PRODUCTIVITY

HEARINGS

BEFORE THE

SUBCOMMITTEE ON GENERAL OVERSIGHT

OF THE

COMMITTEE ON SMALL BUSINESS

HOUSE OF REPRESENTATIVES

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PRODUCTIVITY

TUESDAY, MARCH 23, 1982

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON GENERAL OVERSIGHT,
COMMITTEE ON SMALL BUSINESS,
Washington, D.C.

The subcommittee met, pursuant to notice, at 10:30 a.m., in room 2361, Rayburn House Office Building, the Hon. John J. LaFalce (chairman of the subcommittee) presiding.

Mr. LAFALCE. The Subcommittee on General Oversight of the House Small Business Committee will come to order.

OPENING STATEMENT OF CHAIRMAN LaFALCE

Mr. LAFALCE. Both this morning and tomorrow morning our subcommittee shall hold hearings on the issue of American productivity. There are few issues more in need of further study. A number of years ago mention of the word "productivity" was greeted with scant attention. It was viewed as an esoteric concept which had little relevance to quarterly profit reports or long-range business planning. Some of us in Congress did address the issue of declining American productivity and supported efforts which would focus the Nation's attention on the topic, and define the appropriate role for the Government to take in achieving what truly must be a priority of American industry, the improvement of technological and human productivity so that the economy may grow, and businesses may prosper.

One result of our efforts and warnings about the importance of productivity was the creation of the National Center on Productivity and the Quality of Working Life, and its progeny of commissions, agencies, and committees to address these issues.

Several years later, though, the comprehensive effort by the Government to address the issue of productivity, not to dictate policy, but simply to serve a positive role in elucidating the problem, is still lacking. Not surprisingly, the result of this inaction has been declining rates of productivity and the erosion of the marketplace for our goods by other countries, notably Japan, which have focused attention on productivity improvement.

In the period 1967 to 1973, manufacturing productivity in the U.S. grew by 2.9 percent, while in Japan the growth rate was 10.4 percent. For the 1973 to 1980 period, the growth rate here was a mere 1.7 percent compared to a 7.2 percent growth rate in Japan.

In 1978, 1979, and 1980, we actually experienced in the United States an overall decline in productivity. The figures are in for 1981 now, and the overall rate shows a slight growth of just .9 per-

cent. Our pleasure in seeing this apparent reverse in our fortunes must be necessarily muted, however, by the recognition that productivity in the fourth quarter of 1981 fell by a recordbreaking 7.6 percent.

Clearly, if we try to resolve our economic woes without addressing this productivity crisis, it will be a futile effort. Notwithstanding the general productivity declines, there are some encouraging signs to which we can point.

First, the productivity issue is finally getting the attention it deserves. Mention of productivity, which was once met with drooping eyelids or blank stares, is now greeted with intense interest and attention. The very word "productivity" is now on everyone's tongue.

Second, despite the national statistics on productivity, there have been several isolated instances of tremendous productivity growth. It is an articulation of these successes improving productivity to which a considerable portion of these 2 days of hearings will be focused.

We are pleased to have with us at these hearings noted authorities on productivity from both the public and private sectors. Their experiences run the gamut from promoting technological innovation to encouraging better managerial techniques.

At tomorrow's hearing we will have witnesses from the public sector and private industry who will share their perspectives on productivity improvement programs which are in place in both large and small companies and which have resulted in notable achievements.

This morning, though, we are especially pleased to hear from three experts on the productivity issue. With us are Joji Arai from the Washington office of the Japan Productivity Center. I first met Mr. Arai years ago—I think it was 1975 or 1976, as I recall, when we first met—and this past August 1981 we had occasion to truly deepen our relationship and friendship when Mr. Arai was kind enough to be my host on a tour of Japanese industry, primarily in the Tokyo area.

We also have with us Mr. Brian Usilaner, the director of the National Productivity Group at the U.S. General Accounting Office. Again, it has been my pleasure over the years to work with Mr. Usilaner who has issued some of the finest reports coming from GAO on the issue of productivity. We also have Mr. John Stepp, the director of the U.S. Department of Labor's Office of Labor-Management Relations Services.

We have very valuable lessons to learn from these hearings and we are pleased that you gentlemen are able to be here today. Mr. Arai, I would like to begin the hearing with your testimony.

TESTIMONY OF JOJI ARAI, MANAGER, WASHINGTON OFFICE, JAPAN PRODUCTIVITY CENTER

Mr. ARAI. Mr. Chairman, members of the subcommittee, thank you very much for affording me this opportunity to relate to you the current condition of small business in Japan, their productivity performance and its impact on her economy.

In the manufacturing sector as of 1978, small business represented 99.5 percent of the total number of firms; 73.2 percent of total

workers owned 45 percent of plants and equipment; shipped 53.3 percent of total products; and contributed 58 percent of total value added.

Mr. LAFALCE. So, when people speak of Japan, Inc., and they think of just large business and Government, they are really missing the picture in Japan.

Mr. ARAI. That is true.

Mr. LAFALCE. Part of the secret of Japan's success has been the vibrant success of its small business community.

Mr. ARAI. That is very true. For instance in the automobile industry, the contribution of small business vendors to automobile companies as manufacturers of parts and components is equal to that of large companies. The output by small business of precision machinery, electrical machinery, rose over 100 percent from the 1975 level, general machinery, transportation equipment, and nonferrous metal rose 50 percent.

In order to produce these achievements, the small business sector invested in new plants and equipment at the annual increase rate of 19 percent between 1965 and 1973. However, the rate of investment drastically dropped to 4 percent between 1974 through 1979 after the first Arab oil embargo, which triggered worldwide economic recession.

The retail and wholesale sector maintained a relatively high investment rate and the total input by small business rose over 250 percent from 1960 to 1980 in retail business, and 100 percent in the wholesale business.

The retail and wholesale sector of small business represents 99.7 percent of the total establishment, employs 88.9 percent of labor and sells 79.2 percent of the merchandise.

The important contribution small business can make toward the growth of the country was significantly manifested when Japan began to recover from the impact of the worldwide recession in 1978 and 1979. Although a 36.7 percent contribution was made in 1979 by the private sector for a 6-percent rise in GNP in Japan, 21.6 percent came from small business. This high rate of increase in investment by small business raised the value-added productivity per worker in small business 180 percent in the last decade.

Although the high growth rate of the small business sector was one of the results of increased investment, it was accomplished through the sensitivity of entrepreneurs toward rapidly changing market needs. Many traditional products were withdrawn from the marketplace, and a highly competitive domestic market forced many to go bankrupt unless they had undergone changes in products and services, automated their facilities, reduced costs and increased efforts in research and development.

The amount of investment by small business in research and development increased 3.8 times between 1970 and 1979 as compared to a 3.6 times increase for large business.

The number of researchers increased 1.7 times during the same period for both small and large business. It is estimated that one-third of the increase in output by small business in the 20-year period between 1958 and 1978 resulted from technological innovations.

Small business as compared to its larger counterparts shows a shorter maturing period of development, that is between 3 months to 1 year versus 1 to 2 years for large business, reflecting their flexibility to cope with changes in the marketplace. They also show a relatively high success rate in research and development projects which they undertake. In the chemical industry, for instance, small business spends about 4 percent of sales in R. & D., and in the communications and electronics industry about 3 percent is spent.

The major objective of R. & D. investment by small business has been and will be: One, improvement of quality of the existing line of products; two, new product development; three, cost reduction; four, improvement in quality control; five, improvement in production processes; six, reduction in energy input.

As for automation and the cost reduction, the result of a 1980 survey of small manufacturers shows that over 58 percent of the respondents indicated that the largest portion of their investment went into automation and related equipment, and 41 percent for equipment and devices for production of the smallest possible lot with the largest variety. In designing: Computer-aided photoprinting, automatic programing devices, automatic designing machine, computer-aided equipment, and weaving machines were introduced widely. Others that became popular in the small business sector were as follows: In machining operations, numerically and computer-controlled machine tools, industrial robots, automatic painting machines. In assembly operations: Auto bounding machines, auto-welding machines, auto-screwing machines, and finger jointers. In warehousing and distribution: Vertical automated warehousing, automatic vendors, POS systems, and automatic collators. In office operations: Office computers, Japanese word processors, facsimile transmitters.

In addition to this hardware, the application of quality control techniques and process technology developed by large industries, such as stockless production methods, minimum stock time, and "just-in-time method," helped small businesses to reduce the cost of production of goods and services. In order to insure wider application of computers by small business, a leasing company was formed by manufacturers of computers with encouragement of the Government. The same method is used in leasing of industrial robots to small business. Many local governments are getting involved in order to assure the proliferation of industrial robots by small business in their jurisdiction.

Prefectural industrial laboratories develop playback robots for multiple use by small business and will soon be conducting demonstrations and counseling on the selection and training of operators. Not only is special financing available from public financial institutions in addition to accelerated depreciation effective in April 1980, but also prefectural governments such as Hiroshima and Kobe will be offering robot financing specifically for establishments with less than 150 employees.

In spite of advances small business has made in the past two decades, fundamental weaknesses still place them in the lower stratum of our dual economic structure. Value added productivity of small business in 1980 was still at the level of 54.8 percent of large business and labor-equipment ratio of 43.3 percent.

The salary level of an average small business worker is about 58 percent that of his counterpart in a large business. Of total bankruptcies in 1980, which numbered 17,884, small business accounted for 17,842 of them. Small business pays about 1.5 percent higher interest to lending institutions. The average age of small business employees is older than their large business counterparts and their mobility is higher. This trend resulted in an increased burden on small businesses, lowering of morale and productivity, as well as a shortage of management posts.

Lacking sufficient capabilities to do their own research and development, small business is highly reliant upon larger business for technical and technological expertise as well as financial and management assistance. This, in turn, ties small companies to larger ones as their vendors who have to abide by tight and frequent delivery schedules imposed by the "just-in-time" and the other production programs.

For a small business to move out of this dilemma, they must improve the debt-equity ratio, develop their own technical expertise, train and maintain multiple-skill workers, develop effective strategic plans and deploy efficient market strategy.

To help ease the problems confronting small business, Government through three public financial institutions offer up to $20 billion in loans to small business. It also authorized a writeoff of 14 percent on the purchase of new machinery costing over $5,000 by small business so as to facilitate modernization of their facilities.

We at the Japan Productivity Center developed a series of programs specifically designed for small business. In cooperation with public financial corporations established exclusively for the purpose of assisting small business we conduct an overseas executive exchange program. Under the program a large number of small business owners and managers have been brought to the United States to exchange views and ideas with their counterparts and to be exposed to the American way of managing business.

A joint study was conducted in conjunction with the Ministry of International Trade and Industry to introduce American type venture capital, concepts of small business investment companies, voluntary retail and wholesale sponsored chains and other forms of merchandising practices prevalent in the United States.

Many Federal and local government sponsored small business programs of the United States, such as Small Business Institute, and Small Business Development Corp. were studied by the officials under our auspices so that ideas could be transplanted to Japan. To encourage the wider application of computers by small business, we have also initiated a training program for computer programing and systems analysis specifically designed for employees of small business so that they will benefit from the in-house expertise rather than competing with large businesses in the labor market for software specialists.

Still lack of capital, technical expertise, and reliance on big business will handicap them in attaining the economic strength comparable to that of big business, and make them more susceptible to the down turn of our economy as compared to their American counterpart. Japanese believe that we still have a great deal to learn from our American counterparts.

Thank you very much.

Mr. LAFALCE. Joji, thank you very much for your testimony which is so focused on small business. I am appreciative of that. One thing I did notice is that you do have an unusually high bankruptcy rate in Japan, do you not? That is not something that you discourage. It is my understanding of the Japanese philosophy that you want to encourage small businesses to start up and fly their wings, and, if they can't fly, so be it. You are more interested in helping those who have the ability to fly, to fly higher, faster, and greater, rather than just to keep them from failing.

Mr. ARAI. That is true. I would like to indicate that the average bankruptcy ratio, even under normal economic conditions is 1,000 per month, and during a recession the number increases to about 1,500.

Of course, we also have the reverse figures in that we see about 50 percent more new businesses start. Actually, most of the 1,000 establishments going into bankruptcy are marginal businesses and those people are constantly going into new businesses. So actually the survival ratio is 50 percent. Therefore, even though we do have insurance policies and counseling programs initiated by Government to prevent a large number of bankruptcies, we still will continue to see the same ratio of bankruptcy in Japan because we have a very large number of small businesses employing up to only 10 people, and those are the ones that go into bankruptcy.

Mr. LAFALCE. Now, I just said that you don't do much to prevent your businesses from going into bankruptcy. Is that really true? Does Japan have any special programs to help small businesses get started and when the businesses go into bankruptcy, does the Japanese Government suffer that loss? Is there some special type of financial assistance the Japanese Government gives to start up small business?

Mr. ARAI. Yes, there are three public financial institutions which are established by the Government of Japan with substantial funding from the Government to extend loans to small businesses, depending upon the size of the company and the capitalization. The entrepreneurs can go to different types of financial institutions for loans.

Mr. LAFALCE. You said three types of financial institutions. Could you spell that out?

Mr. ARAI. Yes. There is one called National Finance Corporation which was established for the purpose of aiding very small business, an organization employing upward of about say 10 people.

The second category of public financial institution is called Bank for Small Business. They help out organizations between say 10 and 100 employees. For anything beyond that, there is a central bank for associations of commerce and industry and they do help out medium-size industry. Those are the organizations employing close to 300 people. Total lending capacity of those three public institutions combined will be somewhere around $20 billion.

Mr. LAFALCE. $20 billion?

Mr. ARAI. Yes.

Mr. LAFALCE. Wow.

Mr. ARAI. In addition to the financial assistance, there is a government insurance program to take care of the bankruptcy cases.

Also, counseling is available from both the National Government as well as prefectural government to prevent bankruptcies of small business.

Mr. LAFALCE. Let's discuss that for a bit. So, you say these three agencies have approximately $20 billion that is available to assist basically small businesses?

Mr. ARAI. Yes, sir.

Mr. LAFALCE. $20 billion to be put in comparative terms with the United States, what would your national budget be this year, Joji, in Japan compared to the United States. We don't know exactly, but it will be around $750 billion roughly. What is Japan's?

Mr. ARAI. Japan's is somewhere around $200 billion, I believe.

Mr. LAFALCE. $200 billion. So, OK, that is almost like $70 billion in the United States then just for small business.

Mr. ARAI. Right, but I have to point out that those public financial institutions have been in business for a long period of time. They have their own rolling fund available. The Government does supply needed capital to those financial institutions on an annual basis, but that amount is not——

Mr. LAFALCE. So, the $20 billion is not out of the $200 billion. This $20 billion might well be within their assets?

Mr. ARAI. Yes.

Mr. LAFALCE. Or a portion of the $20 billion.

Now, if the small business goes to the National Finance Corporation, is that small business which has 10 or fewer employees likely to get 100 percent of its financing from the National Finance Corporation, or would it get just a certain percentage of it from NFC. Would it have to get the balance from a private lending institution?

Mr. ARAI. Well, they have numerous provisions with respect to the qualification of loan recipients and they have to——

Mr. LAFALCE. Sorry. I didn't catch that.

Mr. ARAI. They do specify terms and conditions and the qualifications of loan recipient. Therefore, depending upon the financial condition, I suppose that the percentage varies. However, usually the National Finance Corporation, in addition to extending loans, extends the management service in order to assure that they don't go bankrupt. As for the exact percentage of needed capital a loan applicant can receive, I do not know.

Mr. LAFALCE. I was just curious whether or not the National Finance Corporation might be putting up say 10 percent of the debt finance, or it would be closer to 90 percent.

Mr. ARAI. A very substantial portion of the needed capital.

Mr. LAFALCE. Oh, it is very substantial.

Mr. ARAI. Right.

Mr. LAFALCE. So, it might be closer to 90 than the 10?

Mr. ARAI. I would be reluctant to give you exact figures.

Mr. LAFALCE. But substantial?

Mr. ARAI. Yes. In addition to those public financial institutions, there are commercial institutions that are available to assist such as the mutual savings banks, the credit unions, and the provincial banks.

Mr. LAFALCE. Do these banks engage just in debt financing, or do they also engage in equity financing?

Mr. ARAI. Mostly debt financing because the net asset of the average Japanese corporation is somewhere between 15 and 25 percent.

Mr. LAFALCE. You mentioned that this $20 billion is in direct loans. Correct?

Mr. ARAI. That is correct.

Mr. LAFALCE. Well, first of all, let's stick with that. Is this a subsidized interest rate? What type of interest rate do you charge?

Mr. ARAI. The interest rate is not so different from the rate charged by commercial institutions, only that those who have to go to public institutions do not have a high enough credit standing. Thus, they have difficulty receiving loans from the regular private financial institutions. Therefore, they go to those public ones.

Mr. LAFALCE. I see. Do you charge market interest rates?

Mr. ARAI. Usually, they do. My understanding is that they do charge market rate.

Mr. LAFALCE. What is the market interest rate in Japan right now?

Mr. ARAI. The primary at the moment is, I believe, about 7.5 percent.

Mr. LAFALCE. 7.5 percent?

Mr. ARAI. Yes.

Mr. LAFALCE. Is there any way for American businesses to borrow from Japan?

Mr. ARAI. Any time.

Mr. LAFALCE. See you later.

Joji, what about the maturity of these loans to small businesses? Are there special programs, are there special maturity terms? Do they repay the loans over a longer period of time if they get financing from any of these three banks? Do small businesses get better terms, than they could from private financial institutions?

Mr. ARAI. Maturity period of loan, I understand, is just about the same as any loans offered by private institutions. If you borrow, of course, from the Government institutions, there is the guarantee. You are buying insurance; therefore, the loan will be protected. As far as the maturity is concerned, I think it is the same as any other loan.

Mr. LAFALCE. We have been talking exclusively about loans. Let's also talk about the the special Government insurance program you mentioned. In the United States, we have the SBA and we have a government guarantee program. That is the basic program, although it is being cut back tremendously from around $4.4 billion to about $2.2 billion and that is in a much larger economy, at least now. Tell me a little bit about your Government insurance program. How large is it, and how does it work for small business? Who is the insurer?

Mr. ARAI. Well, the insurer is this insurance corporation, which is a public corporation.

Mr. LAFALCE. So, there is an insurance corporation. What is it called?

Mr. ARAI. It is called the Small Business Insurance Corp. I do not know the exact official translation of the Japanese organization. However, they do offer insurance to small business who have to receive loans from financial institutions. Other than that, I am not

too familiar with the insurance program, which is being offered to small business. I will be happy to compile the report for you, if you like.

Mr. LAFALCE. Would you? I am just curious how that works. An insurance and a guarantee are very similar.

Mr. ARAI. Yes.

Mr. LAFALCE. I am just curious as to how Japan's program works in that respect. I would like some more information.

[The information requested follows:]

INSURANCE PROGRAM

This program is administered by the Small Business Credit Insurance Corporation with a reserve fund of approximately $200 million, and a loan fund of $120 million. The maximum insured amount is $350,000.

One of the insurance programs designed for system technology transfer guarantees an insurance payment up to a limit of $500,000.

The insurance company loans funds to credit associations together with prefectural governments, which in turn entrusts the funds to private financial institutions for lending to small businesses.

Retail and wholesale stores competing with large chain stores can receive loans up to $100,000 with an interest rate of 7.6 percent with maturity of between 5 and 7 years for capital investment, and 3 to 5 years for operating funds.

This loan is also available to small business subcontractors as well as those small businesses qualifying for regional industrial programs.

Mr. ARAI. I have to point out to you that many of those programs the Japanese initiated to foster the growth of small business was learned from Americans.

Mr. LAFALCE. I know that. Mr. Demming probably advised you to embark upon something like this.

Mr. ARAI. Well, he is one of them.

Mr. LAFALCE. Well, I was interested, you apparently have special programs too for special industries, special pursuits that you think are especially important. So, you target your assistance too, and I was intrigued by what you are doing with computers and robots. Let's just take computers now. You talked about the creation of a leasing company formed by manufacturers of computers with the encouragement of the Government so that there could be some special type of leasing robots to small business. Can you expand upon that a bit?

Mr. ARAI. Well, originally, the computer used to cost a great deal and not many small businesses were able to purchase the equipment. Therefore, the manufacturers got together and formed this leasing corporation which enabled the smaller industries to lease equipment for low rental. Of course, the cost of the computer became considerably lower in time. Many small size computers with greater capacity can now be made available to small business for daily use, but originally, when the computer leasing corporation was formed, the primary purpose was to enable small business to have ready access to large size computers which were not available to them because of the weak financial capability of small business at that time.

Mr. USILANER. This gets at a problem in this country; the proliferation of robotics in larger companies is no problem, but statistics show that they are not being purchased or even leased in ways that many small business manufacturers can get involved, and make use of this technology.

Mr. LAFALCE. So if we are to turn increasingly to robots in the future, as I think we must and will, and if this tendency prevails, it could lead to the extinction of small business, which is unable to obtain robots unless we develop some special type of program.

Mr. USILANER. That is why the statistics are deceiving in terms of how we are utilizing robotics. You have to look deeply into it. I understand you have someone coming from the Robotics Institute tomorrow. It is mainly the larger manufacturers who are making use of them.

Mr. LAFALCE. Joji, could you supplement your testimony and your answer in writing with exactly what was done by manufacturers of computers to come up with this leasing company to make computers available to small business? Also, what exactly was done by the Government of Japan to encourage this?

[The information requested follows:]

The Japan Robot Leasing Company was established in April 1980 by a group of robot manufacturers, banks, insurance and leasing companies with capitalization of about $2 million. Sixty percent of the fund was made available from the Government through the Japan Development Bank and 40 percent from commercial banks.

Loans are guaranteed by the manufacturers depending upon the type of equipment. The leasing period ranges from between 3 to 8 years.

There are over one hundred different types of robots and manipulators for which leasing arrangements can be made through the company. There are some 42 manufacturers involved.

Mr. ARAI. Originally, when the idea was suggested, the Government took initiative in the formation of the corporation.

Mr. LAFALCE. Which corporation was it?

Mr. ARAI. The leasing corporation.

Mr. LAFALCE. The leasing corporation. Is it a public corporation or private corporation?

Mr. ARAI. It is a private corporation, as far as I know, because it has been formed by the Association of Manufacturers of Computers in Japan to attain the proliferation of computers in the private small business sector. I do not know the exact capitalization or manner in which the leasing agreement has been concluded with small business lessees. I would have to look into the details of the corporation. If you like, I will be happy to give you more detailed information on the corporation. As far as the proliferation of computers in small business is concerned, I think that this corporation did help a great deal.

Mr. USILANER. Mr. Chairman, we are examining robotics, and automated manufacturing in this country. We are looking at the Japanese Government's role in stimulating the use of robotics to see if there are any lessons we can learn. An important part of their program is the special treatment loans to small business, specifically for the purchase of robotics.

Mr. LAFALCE. I was just about to question him, because in your statement you say there is special financing, Joji, that is available from public financial institutions to small businesses with less than 150 employees, specifically for robot financing. Could you expand upon that a bit?

Mr. ARAI. Yes, there is the special category fund, called small business modernization fund, which is available from various public financial institutions, as well as the prefectural financial in-

stitutions. They do help out small business in procuring and purchasing industrial robots.

[The information requested follows:]

In addition to the financial assistance available for purchasing industrial robots, small business, purchasing equipment costing over $5,000, which includes the industrial robot, qualify for a 14-percent writeoff. In addition to that, if a small business purchased, or if anyone purchased industrial robots with a memory of over 60K bytes, they can qualify for, I believe, a 14-percent writeoff. Since the depreciation of industrial robots is a 7-year period, this means that the fixed rate amounts to somewhere around 14 percent. Actually, if you are a small business, and buy an industrial robot, you qualify first for a 14-percent writeoff, then for a 14-percent depreciation, and then under a special writeoff clause an additional 13 percent.

Mr. LAFALCE. Oh, wow. So, this is cumulative. You are talking about a 14 percent plus a 14 percent plus a 13 percent?

Mr. ARAI. Somewhere around that.

Mr. LAFALCE. You are almost talking about a 50-percent writeoff the first year.

Mr. ARAI. Somewhere around 40 percent, I think, in writeoff. In addition, some of the small——

Mr. LAFALCE. Could you supplement that in writing also, you know, once you get exactly what it is and how it is?

Mr. ARAI. Yes.

Mr. LAFALCE. I would appreciate that.

Mr. USILANER. I can do that also.

[The information requested follows:]

Japan has used several methods to promote robotics. Under the "Special Measures Law Concerning the Promotion of Specific Machinery and Information Industries," which went into effect in July 1978 for 7 years, any company installing a robot can write off 12.5 percent of the cost in the first year in addition to normal depreciation. Under another provision of this law, small- and medium-sized firms can obtain low-interest loans through the Small Business Finance Corporation, a Government-owned financial agency, to purchase robots. In a complementary move backed by the Government, 24 robot makers and 10 insurance companies formed the Japan Robot Leasing Co. (JAROL) in April 1980 to enable small- and medium-sized manufacturers that cannot afford to buy robots outright to lease them. Using funds supplied by the Government-owned Japan Development Bank as well as its own moneys, JAROL buys robots from builders, and then leases them to buyers on terms more advantageous than those offered by Japan's commercial leasing companies. Equally important, JAROL, which is similar to the Japan Electronic Computer Co. set up in the 1960's, provides systems engineering and consultant services to its customers.

Mr. ARAI. In addition to that, some of the prefectural governments are now offering financial assistance to those small business purchases of a robotic unit and they do offer upward of $150,000. Since the average cost of playback robots in Japan is somewhere around $50,000, they qualify for a low-interest loan from prefectural financial institutions upward of three units.

Mr. LAFALCE. What would a low-interest loan be?

Mr. ARAI. I have no idea what the exact rate is.

Mr. LAFALCE. From 2 to 3 percent; maybe 7½ percent?

Mr. ARAI. This is a new program, and I don't believe they have set the rate yet.

Mr. LAFALCE. What about the rates charged by the national Government's public financial institutions for robot financing? Is that as a concessional loan a lower interest rate also?

Mr. ARAI. I do not have the exact interest rate available on the loans for the specific purpose of purchasing industrial robots.

Mr. LAFALCE. Brian, do you have anything on that?

Mr. USILANER. I only know that the interest is below market.

Mr. LAFALCE. Well, it is obvious though that the Japan Government has made a conscious decision that it must do everything possible to facilitate small business ability to gain access to both the computer market and especially the utilization of robots.

Mr. ARAI. That is correct.

Mr. LAFALCE. If that is exactly the opposite of what is happening in the United States, we have some serious problems. No one in the Congress or the administration has——

Mr. USILANER. Not in the Government.

Mr. LAFALCE. Now, have you done a special report on this yet, Brian? Has it been released?

Mr. USILANER. No, I was just telling Jim Klein of your staff, we have finished the audit work, and now we are writing the report.

Mr. LAFALCE. So, the report hasn't been written. Would you make sure that I see the draft as soon as you have the draft?

Mr. USILANER. I told Mr. Klein we would be glad to brief you.

Mr. LAFALCE. All right. Fine.

Joji, before we finish up, you talked a bit about the importance of giving counseling on management and, apparently, most of this is done on the national level as opposed to your prefectures. Describe that more fully, please.

Mr. ARAI. Our SBA counterpart is called the Small Enterprise Agency and they have offices throughout Japan.

Mr. LAFALCE. So, you have a Small Enterprise Agency, too. We haven't heard that one before.

Well, between the Small Enterprise Agency and the National Finance Corporation, the Bank for Small Business, and the Central Bank, which assists primarily businesses 300 employees or less, and the Small Business Insurance Corporation, et cetera, how much management assistance do you give to your small business community?

In the United States we have a tremendous management assistance program for small businessmen who happen to be farmers. I mean, if you are a farmer, we have an agency, the Cooperative Extension, in virtually every single county in America. That is one of the reasons that American farmers have done so magnificently. The Government has helped them tremendously with management assistance. But for the small business community which happens not to be in the agricultural sector, we have almost no management assistance programs to speak of. Oh, we have somebody at SBA, the associate administrator for management or technical assistance, but I think even he would admit that we do relatively little, certainly not as much as we should. Could you expand on that a bit?

Mr. ARAI. Well, management assistance actually is available from three different sources to small business in Japan. One is, of course, from the regional offices of the Small Enterprise Agency, and the second one, is those financial institutions which extend loans. They have to protect their loans, and the best way of doing that is to make certain that there is effective management running the business. Therefore, they do go to the small business loan recipient to make certain that they run the organizations effectively.

The third source is the purchaser of the parts equipment and services provided by small business. In Japan, we find a very close affiliation between small business and large business, and our large business has a tendency to force small business to acquire expertise in technological areas, as well as production processes, so that whenever small business deliver parts and components without inspection large business can incorporate those wares into the final products they assemble.

Therefore, a tremendous amount of knowledge and skill and assistance is given by large business to small business. That way large business feels that they benefit a great deal. So, quite often we find teams of managers from large business visiting small business vendors to make certain that they acquire the skill in process technology as well as quality control and that they institute an effective management control program. Therefore, they can be assured of the 100-percent perfect parts and the components. So, small business in Japan can receive management assistance from those three different sources.

Mr. LAFALCE. That is very interesting, Joji. Now, I don't have any way to quantify what you do in Japan. I don't have any way to quantify what we do in the United States so far as delivering management assistance yet. I have got one week's experience in Japan. You have been in the United States now for close to a decade.

Mr. ARAI. Twenty years.

Mr. LAFALCE. Twenty years. How many times greater would Japan's efforts be in providing management assistance to small business than United States efforts to give management assistance to small business? Can you make an estimate? Do you have a feel for it?

Mr. ARAI. Well, it is not a quantifiable area. Therefore, it is rather difficult to say what percentage of management assistance is given to small business from various sources in Japan, as compared to the practice here in the United States, but I certainly can tell you that the Japanese small business is more heavily reliant on the outside assistance than their American counterparts. We found that in the United States when you have an amateur entrepreneur starting a business that he usually, if he is in the manufacturing business, has a few patents which he himself developed.

On the contrary, in Japan, we have the affiliation of an entrepreneur with a larger business. Therefore, the entrepreneur inherits the technical and management expertise from large business. There is a constant flow of goods and services between large business and small business. In addition to that, there is the official assistance program. I will say that Japanese small business have ready access to more sophisticated management expertise from various sources, as compared to U.S. small business entrepreneurs, who primarily depend on his own expertise in starting and carrying on the business.

Mr. LAFALCE. Brian, have you done any studies on this?

Mr. USILANER. No.

Mr. LAFALCE. Joji, do you have any specific recommendations as to what we could do in the United States, just in the area of management assistance?

Mr. ARAI. Well, I certainly believe that small business should have ready access to sophisticated management techniques, which are only available at this time to large business, particularly in the area of development of strategic plans. I know that in the future unless you have very good strategic plans, even for a small corporation, they will have difficulty in coping with rapidly appearing changes in the marketplace. Being independent and creative in starting a business is a good idea. On the other hand you tend to become rather dogmatic in running a business that way. Therefore, I think the outside input is necessary in addition to the type of management assistance being offered by your Government, SBA and a few others. More sophisticated management assistance programs, particularly new techniques, a merging of techniques, should be made available to small business. Of course, a tax write-off and depreciation in making the highly sophisticated automatic equipment, industrial robots and the computers, would be desirable in strengthening the economic base of the small business.

Mr. LAFALCE. The SBA has a SCORE program, Service Corps of Retired Executives.

Mr. ARAI. I am aware of that.

Mr. LAFALCE. I am curious as to whether or not they might be educating them about the way to be successful 20 years ago. I don't know.

Mr. ARAI. I would be reluctant to comment.

Mr. LAFALCE. I won't ask.

You say that the Japanese Productivity Center has developed a series of programs specifically designed for small business, but the only thing you mentioned was the overseas executive exchange program. Is there anything above and beyond that which the productivity center itself is doing for small business?

Mr. ARAI. Well, we have the overseas executive exchange program plus the computer program designed specifically for small business. We have a very large size computer, and we actually encourage small business to hook up their unit into ours so that they have ready access to information relating to wage scale and industrial relations matters.

We have developed a program in which we put into our data bank macroeconomic information as well as industry data so at the time of labor negotiations they can both—that is, management and labor—can hook onto our databank. Therefore, they have ready access to information at the time of the negotiation. Since most of the disputes at labor negotiations arise from the interpretation of numbers, our system helps solve the industrial dispute.

As a matter of fact, in some of the industrial sectors where we initiated the program we see few strikes. In addition to that, of course, we offer a labor-management counsel program. This program applies not only to large business but also to small business. This is a program in which we help both management and labor establish a counseling house composed of representatives from both sides and they meet frequently to discuss various management issues, industrial relations issues and strategic plans, et cetera that at the time of the renewal of their contract they do not have in their dispute. Those are the other types of programs we offer, but

they do apply to small business, just as much as large business. Therefore, I did not touch upon them in my testimony.

Mr. LAFALCE. Very interesting.

One other thing, you mentioned that the National Government recently has come up with a small business modernization fund program. Can you expand upon that now, and how much money is in that pot, and what do you use it for? Obviously for robots; but what else?

Mr. ARAI. I do not know the specific machinery included in that category, which——

Mr. LAFALCE. Who runs the program?

Mr. ARAI. It is run by the National Government. It is run by, I believe, the Small Enterprise Agency and I think the participating financial institutions offer the funds. Exact items, as I indicated to you, which fall into the application of the particular fund, I do not know. It has been in existence for some time, and it helps small business in acquiring automated equipment, numerically controlled, or computer numerically-controlled machine tools, as well as machining centers, computers and the industrial robots. They all fall into the category.

Also, I believe there is a special fund available for small business and large business in the procurement of pollution control and abatement equipment. That equipment also qualifies you for a 20 percent outright writeoff in the tax law.

Mr. LAFALCE. Very good.

That will conclude my questions. Joji, I want to thank you very much. You are free to stay or leave, whatever your pleasure might be.

We are now going to turn our attention to a representative from GAO, Mr. Brian Usilaner. We will introduce the entire text of your remarks, and ask you to just summarize it now.

TESTIMONY OF BRIAN L. USILANER, ASSOCIATE DIRECTOR, NATIONAL PRODUCTIVITY GROUP, U.S. GENERAL ACCOUNTING OFFICE

Mr. USILANER. First, let me say that we appreciate your leadership in the Congress, Mr. Chairman, in keeping productivity issues high on the agenda of congressional concerns and, obviously, you have provided us with a lot of support and interest for the studies that we have done on productivity. I happened to see a recent Harris survey that backs up the point you made at the beginning of your statement that shows some 79 percent of the American public believe that productivity is a serious problem that deserves urgent action.

Mr. LAFALCE. Do you have any polls of about 5 to 8 years ago when we were first starting to try to get other's attention to the productivity issue?

Mr. USILANER. Yes; the old productivity center had commissioned a Louis Harris survey.

Mr. LAFALCE. Do you know what that data is?

Mr. USILANER. Well below 79 percent.

Mr. LAFALCE. It would be interesting to make a comparison. Please provide me that, OK?

Mr. USILANER. In 1972, only 37 percent thought the country as a whole benefited a lot from productivity growth.

In both the public and private sectors widespread recognition of the productivity problem is now being translated into action. While much of this activity is in an early stage of development, it is a hopeful sign. The question now is whether this action is substantive, and will produce significant results. In my testimony today, Mr. Chairman, I would like to share with you some of our findings about private sector initiatives to improve productivity, what we consider to be the key elements in an effort to improve productivity in any organization and what some Federal agencies are now doing along these lines. Finally, we will offer some thoughts on how the Congress and the executive branch can help bring about greater productivity improvement in Federal agencies. In our work related to productivity in the private sector, we have examined approaches to productivity improvement in many companies of all sizes. During 1980, we visited some 54 companies, including many small firms, to examine their experience and attitudes regarding productivity sharing as a technique for improving productivity. We found that firms with productivity sharing plans experienced a 17-percent average annual reduction in workforce costs. In addition, these firms reported such important nonmonetary benefits as improved labor-management relations, reduced grievances, less absenteeism and reduced turnover.

The combined effect of these indicators was a substantial increase in productivity. We were encouraged by the level of commitment these firms demonstrated to improving productivity.

Another approach to productivity that has become increasingly popular in the private sector is the establishment of formal productivity improvement programs. This is evidenced by a new management title that has been springing up on the corporate organization charts; that title is productivity manager. These managers have different roles and responsibilities, but they are all company focal points for productivity improvement.

We recently examined several of the more notable company productivity efforts to get a better understanding of what they are doing. We found fairly consistent reasons for the establishment of formal productivity improvement programs. We felt it was very interesting. Most of the firms told us they had long been able to rely on increases in prices or volume to meet their profit objectives. Productivity simply was not a major concern so long as profit goals were met. Beginning in the late 1970's, however, many of the firms found that their markets were not willing to accept higher prices and more volume. At the same time, they were faced with increasing labor and supply costs as well as heightened international competitiveness. This dilemma forced the firms to look inward and find ways to reduce costs and improve productivity. Productivity managers were designated to develop corporate strategies for top management that would result in significant productivity improvements.

We found it interesting that at many of the firms, productivity efforts were devoted almost exclusively to human resource productivity. The feeling at most of the firms seemed to be that technological aspects of productivity were being addressed adequately, while

the increasingly important human resource aspects of the problem required special attention.

In terms of results that we found, one firm was able to quickly identify dollar savings in the tens of millions as a direct result of the productivity improvement effort. Another firm noted significant increases in production, reduced scrap, as well as reduced employee turnover, and absenteeism. All of the productivity managers believe their efforts will have significant long-term benefits for their companies. One manager said he even guarantees his superiors that each employee assigned to the productivity staff will save the company over $800,000 per year.

Although each firm has its own approach to organizing a formal productivity program, we found they all have certain common elements. We believe the seven elements we have identified are needed in any organizationwide productivity effort in either the public or private sectors.

These are: First, providing top level support and commitment to productivity improvement. By this, we do not simply mean a pronouncement by the top executive, but a continuing involvement by this person in insuring that productivity is improved.

Second, establish a high level manager to serve as a focal point for the productivity effort. This manager provides for a continuing emphasis on productivity to insure that it does not get lost in the shuffle, as such efforts have in the past.

Third, generate awareness of productivity's importance to the company. The awareness effort often includes employee involvement and participation in developing ideas on how productivity can be improved.

Fourth, identify productivity objectives and goals and develop an organizationwide productivity plan. The plan is essential since it makes clear to everyone in the organization what needs to be done to meet the goals.

Fifth is the development of productivity measures that are meaningful to the organization.

Sixth, use the productivity plan and measurement system to hold employees accountable for productivity improvement. The firms we visited all emphasized manager accountability for productivity in their programs. At several of these firms this was done by specifying expected productivity rates for various measured activities, comparing actual to expected, and then, most importantly, using this data in assessing managerial performance, compensation, and bonuses.

Seventh, provide for a continuing review of operations to identify potential areas for improvement.

We believe these seven elements are necessary for an effective productivity effort in either the private or public sector.

Turning now to the public sector, during the most recently measured period. Federal productivity improved at an annual rate of 1.4 percent. While this compares favorably to the negligible productivity growth trend in the private sector, we believe much more can be done.

In our current examination of Federal efforts to improve productivity, we are finding that most agencies have only small, narrowly

conceived productivity efforts that encompass very few, if any, of the seven elements we mentioned.

Consequently, these agencies are missing opportunities to reduce costs and/or increase output through productivity improvement. There are, however, several encouraging efforts. I would briefly like to highlight some of these for you today.

Concern about productivity improvement is evident within the top management echelon of the Department of Defense. The Deputy Secretary has recently established a high level council on integrity and management improvement. The council is requesting that each service develop plans for management and productivity improvement actions. The plans, once approved, are intended to be used to provide incentives for managers at all levels to develop new and better ways of managing defense activities.

Furthermore, the Air Force, Navy, and Army are engaged in their own productivity improvement activities. Although each service appears to be making substantive progress, our most indepth look at this time has been with the Air Force productivity enhancement program.

A most vital and effective part of this program is the policy that allows savings achieved from productivity improvement to be applied to other approved but deferred activities within the organization. This is seen by the productivity staff as the best way to motivate Air Force managers to work for savings.

The approach also overcomes the notorious disincentive to productivity encountered by most managers; namely, budget reductions that match any previous savings. An example of Air Force savings achieved by increased productivity is seen in the results of their fast payback investment program. In 1980–81 275 projects were initiated under this program with estimated life cycle savings of more than $60 million. The Air Force claims a return on investment of seven to one for these projects. These are loans for productivity-enhancing equipment of less than $100,000.

Another Federal organization that has made considerable progress in productivity improvement is the IRS. Two important efforts are the productivity enhancement fund and the management-generated savings program. The former provides for various productivity improvement projects within the service. The latter has a payback incentive which allows managers to retain for their organization 50 percent of the savings generated by improvement projects. IRS's fiscal year 1982 productivity plan listed 215 productivity-related projects of all kinds. The plan reported a savings of almost $27 million for fiscal year 1981.

As an aside, I would like to mention of the——

Mr. LAFALCE. Brian, when you say the IRS's 1982 productivity plan, are they unique in the Federal Government with a productivity plan?

Mr. USILANER. Yes.

Mr. LAFALCE. Doesn't any other agency have a productivity plan?

Mr. USILANER. We have just started, sir, a review of all Federal agencies and what they are doing in productivity, but I would venture to say that they are one of the few. The Air Force, as I mentioned, also has a plan, but very few agencies have them and, as we

mentioned, we consider such a plan to be an important ingredient in the success of a productivity program. I would also like to mention an example of the important role Federal managers can play given the right conditions in improving productivity. In a recent GAO study, we found that productivity rates achieved by Federal payment centers, of which there are something like 1,200 throughout the Government, varied by as much as 600 percent. That means that these organizations are doing the same thing, but with productivity rate differences of 600 percent.

Managers at payment centers with high productivity showed a great deal of concern about productivity and had good measurement and reward systems. On the other hand, managers at centers with low productivity had little or no measurement, and expressed little, if any, concern about productivity. The concern was more on paying the bills on time and accurately, not on how efficiently they were doing it.

Mr. LAFALCE. Has this been publicized?

Mr. USILANER. Yes, that report was issued on February 15, 1980. It is known as report FGMSD-80-13.

I should note that officials with productivity programs and Government managers spoke highly of the Office of Personnel Management's efforts in helping them initiate, implement, or improve their programs. OPM's program, which began in 1979, was designed to assist managers improve productivity through management analysis, improved measurement, and information sharing. These officials are concerned that this support from OPM has now been virtually eliminated and they now lack any central support and assistance. Many productivity officials believe——

Mr. LAFALCE. Is there still a Workforce Effectiveness Division within OPM?

Mr. USILANER. No.

Mr. LAFALCE. They have eliminated that?

Mr. USILANER. Just recently.

Many officials believe the elimination of OPM's support may hinder their agencies' efforts to develop and improve effective productivity improvement programs.

Although we are able to point to several positive actions in the Government, we are concerned that not enough is being done. We have found in many of our studies that Federal managers in general are not particulary cost-conscious. This is not entirely their fault since they face at least two obstacles.

First, we have found that a common ingredient to achieve improved productivity in Government is the willingness of managers to take risks. We have heard, however, of instances where risk-taking managers have been penalized or punished rather than rewarded for taking such risks. We plan to follow up on this point in our ongoing review.

Second, the Congress, the administration, and the public are overly concerned with control. Control is obviously necessary, but we have gone so far in trying to prevent every conceivable abuse in Government, to avoid every mistake, to look and be corrected on every occasion, that we have effectively suppressed efforts to improve productivity.

As we have learned from the Japanese, good quality and productivity should go hand in hand and not work against each other. Seldom is anyone in the Congress or the executive branch concerned with whether the same level of service can be provided at less cost. Understandably, most Federal managers respond by putting little emphasis on this area. We would like to see productivity and efficiency concerns made a high priority in Federal agencies. This is especially appropriate in a time of inflation and budget reductions that force managers to do more with less.

As we noted in our past studies, the Congress can help foster increased concern about productivity by encouraging agencies to use productivity data in their budget requests and by then using this data in the appropriation review process. Further, there should be some form of central management assistance as I mentioned, to managers who want to improve the productivity of their organization.

OPM's program has been virtually eliminated just as it was getting up to speed. While there are certainly other ways to reach the objectives OPM has set for itself when it created this productivity assistance effort, we have not seen any significant alternative Government-wide strategy put forth by the administration.

Frankly, we are puzzled by this apparent deemphasis on productivity within the Federal Government during a period of budget reductions. Federal managers need some help in reaching the productivity goals we believe they should be striving for, and that will enable them to produce despite reduced funding and staffing, and increased workloads. We consider productivity in the public sector to be every bit as important as it is in the private sector. The current budget reductions are placing severe demands on many Federal managers. This environment of austerity should be used to nurture increased concern about productivity.

This has been the intelligent response of many private firms that have confronted financial constraints, and it has been the response of some Federal managers. It must be made clear to the Federal managers at all levels that productivity is a matter that deserves to be of high priority and that they will be held accountable for the productive utilization of their resources. We simply cannot afford not to pay more attention to productivity improvement in light of the emphasis to reduce Federal expenditures.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Usilaner follows:]

PREPARED STATEMENT OF BRIAN L. USILANER, ASSOCIATE DIRECTOR, ACCOUNTING AND FINANCIAL MANAGEMENT DIVISION, NATIONAL PRODUCTIVITY GROUP, U.S. GENERAL ACCOUNTING OFFICE

I am pleased to be here today to discuss the continuing need for productivity improvement. As you know, we at the General Accounting Office share your deep concern and interest about this subject. We have issued numerous reports directed at improving productivity in Federal agencies and have often examined and addressed the Federal role in improving national productivity.

We have been pleased to note throughout the country the increasing recognition of productivity's importance. A recent Harris survey conducted for Sentry Insurance found that 79 percent of the American people now believe that declining productivity in this country is a serious problem requiring urgent action. Although the magnitude of the productivity crisis is now widely recognized, the problem still remains.

Productivity improvement in the private and public sectors is more important now than ever. It is needed in the private sector to enable businesses to deal with the financial problems brought on by inflation and increasing international competition. It is needed in Government as budget reductions and inflation force agency managers to deal with ongoing problems and responsibilities with fewer resources.

I am pleased to be able to report that in both sectors, widespread recognition of the productivity problem is now being translated into action. While much of this activity is in an early stage of development, it is a hopeful sign. The question now is whether this action is substantive and will produce significant results.

In my testimony today I would like to share with you some of our findings about private sector initiatives to improve productivity, what we consider to be the key elements in an effort to improve productivity, and what some Federal agencies are now doing along these lines. Finally, we will offer some thoughts on how the Congress and the executive branch can help bring about greater productivity improvement in Federal agencies.

In our work related to productivity in the private sector, we have examined approaches to productivity improvement in many companies. During 1980, we visited 54 companies around the country to examine their experience and attitudes regarding productivity sharing as a technique for improving productivity. Productivity sharing is basically an arrangement in which company management and employees agree that the value of all increases in productivity over a given level will be split between the company and the employees. It is a concept that has been around a long time, but only recently has it become popular, especially among smaller firms.

We found that firms with productivity sharing plans experienced a 17 percent average annual reduction in work-force costs. In addition, these firms reported such important non-monetary benefits as improved labor-management relations, reduced grievances, less absenteeism, and reduced turnover. The combined effect of these indicators was a substantial increase in productivity. We were encouraged by the level of commitment these firms demonstrated to improving productivity. Interest in productivity sharing is now at a peak. Over 11,000 copies of our report have been requested, making it one of GAO's most widely distributed reports.

Another approach to productivity that has become increasingly popular in the private sector is the establishment of formal productivity improvement programs. This is evidence by a new management title that has been springing up on the corporate organization charts of many firms in the past three or four years. That title is productivity manager. These managers have different roles and responsibilities, but they are all company focal points for productivity improvement.

We recently examined seven of the more notable company productivity efforts to get a better understanding of what they are doing. We did this as part of an ongoing review requested by Senator Charles Percy. He asked us to examine Federal agency efforts to improve productvity. Our private sector visits enabled us to develop some criteria for assessing Federal activities.

We found fairly consistent reasons for the establishment of formal productvity programs. Most of the firms told us they had long been able to rely on increases in prices or volume to meet their profit objectives. Productivity simply was not a major concern so long as profit goals were met. Beginning in the late 1970's, however, many of the firms found that their markets were not willing to accept higher prices and volume. At the same time, they were faced with increasing labor and supply costs as well as heightened international competitiveness. This dilemma forced the firms to look inward and find ways to reduce costs and improve productivity. Productivity managers were designated to develop corporate strategies for top management that would result in productivity improvement. Let me provide you with a few examples of what we found.

At Anheuser-Busch the program is directed mostly at improving productivity by first developing employee awareness of the need to reduce costs and increase production, and second by developing productivity-related measures and goals for company managers and holding managers accountable for performance against these measures. Control Data Corporation has in recent years established a small headquarters unit for productivity. The productivity staff serve as consultants to managers throughout the corporation on ways to improve human resource productivity. General Mills has also established a small internal consulting group for productivity. This group works with company managers on various human resource productivity issues ranging from long-range planning to the development and implementation of specific productivity projects.

We found it interesting that many of the firms' productivity efforts were devoted almost exclusively to human resource productivity. The feeling at most of the firms seemed to be that the technological aspects of productivity were being addressed

adequately, while the increasingly important human resource aspects of the productivity problem required special attention.

One company that has combined the human resource and technological aspects of productivity is Westinghouse Corporation. Westinghouse has consolidated all its productivity work in a Center for Productivity and Quality. The Center, with a staff of 240, has four corporate-wide objectives: (1) improve productivity in all corporate functions; (2) improve capital investment; (3) improve product quality; and (4) improve quality of working life. The technology side of the Center is heavily involved in developing robotics and other equipment the company needs that cannot be purchased. The human resource side of the Center is mainly involved with training and employee involvement programs.

While all the productivity managers we met view their programs as important and effective, documented results at this time are limited. This is understandable since the programs are generally new and, in some cases, are geared more toward heightening concern about productivity rather than introducing specific cost reduction techniques.

One firm, however, was able to quickly identify dollar savings in the tens of millions as a direct result of the productivity improvement effort. Another firm noted significant increases in production, reduced scrap, as well as reduced employee turnover and absenteeism. All of the productivity managers believe their efforts will have significant long-term benefits for their companies. One productivity manager said he even guarantees his superiors that each employee assigned to the productivity staff will save the company over $800,000 each year.

Although each firm has its own approach to organizing a formal productivity program, we found they all have certain common elements. We believe the seven common elements we have identified are needed in any organization-wide productivity effort in either the public or private sector. The seven elements are as follows.

First, top level support and commitment to productivity improvement. By this we do not mean a mere pronouncement by the top executive, but a continuing involvement by this person in ensuring that productivity is improved.

Second, establish a high level manager to serve as a focal point for productivity. Each firm we visited considered the designation of a formal productivity focal point to be essential for program success. One productivity manager explained that this is needed to: (1) institutionalize the effort; (2) accumulate and disseminate information on productivity improvement for managers and employees; (3) provide top management with data on productivity performance; (4) increase awareness throughout the organization of the importance of productivity; and (5) provide for continuing emphasis on productivity to ensure that it does not "get lost in the shuffle" as such efforts have in the past.

Third, generate awareness of productivity's importance to the company and involve all employees in the effort. This can include speeches by top management, posters, and video presentations. The awareness campaigns try to eliminate misunderstanding about productivity and make employees realize their importance to the productivity effort. The awareness effort often includes employee involvement and participation in developing ideas on how productivity can be improved.

Fourth, identify productivity objectives and goals and develop an organization-wide productivity plan. The type of plan most appropriate for an organization varies considerably. A plan is essential since it makes clear to everyone in the organization what needs to be done to meet the goals.

Fifth, develop productivity measures that are meaningful to the organization. Productivity measurement is essential, but it is not essential that the productivity measures satisfy all the concerns economists and statisticians often express about technical accuracy. Rather than attempt to develop precise, total factor productivity measures, firms are quite properly using measures that are easy to understand and calculate and are meaningful to top management as well as to those being measured. Some firms use broad measures of gross output over input, sales per employee, or sales over compensation. Other firms use very narrow measures addressing particular problems such as rejects per thousand of a particular unit or energy use per unit of output.

Sixth, use the productivity plan and measurement system to hold employees accountable for productivity improvement. The existence of a productivity plan and a measurement system can be of little benefit unless they are used for this purpose. The firms we visited all emphasized manager accountability for productivity in their programs. At several firms this was done by specifying expected productivity rates for various measured activities, comparing actual to expected, and using this data in assessing managerial performance, compensation, and bonuses. As with the

measurement systems, each firm has developed its own productivity accountability system that seems most appropriate to them.

Seventh, provide a mechanism for examining productivity problems and developing recommendations for their resolution. All but one of the firms we visited had a procedure for identifying methods or changes that can improve productivity. This mechanism is generally called a productivity audit. The audits are conducted by task forces that consist of various individuals with some expertise related to the program or problem under review. The productivity audits are not deficiency oriented. They are designed to resolve problems already recognized by plant managers.

We believe these seven elements are necessary for an effective productivity effort in either the private or public sector. In the most recently measured period, Federal productivity improved at an annual rate of 1.4 percent. While this compares favorably to the negative productivity trend in the private sector, we believe much more can be done. In our current examination of Federal efforts to improve productivity, we are finding that most agencies have only small, narrowly conceived productivity efforts that encompass very few if any of the seven elements we listed. Consequently, these agencies are missing opportunities to reduce costs and/or increase output through productivity improvement. There are, however, several encouraging efforts. I will now briefly highlight two of these efforts aimed at improving productivity that appear well conceived and are being implemented.

Concern about productivity improvement is evident within the top-management echelons of the Department of Defense (DOD). The activities of the recently created Council on Integrity and Management Improvement exemplify this concern. The Council was established by the Deputy Secretary of Defense and consists of such high-level members as the undersecretaries of the military departments. The Council is now focusing its attention on comprehensive management improvement plans that were requested from each service. The plans, once approved, are intended to be used to provide incentives for managers at all levels to develop new and better ways of managing defense activities. The Deputy Secretary has described the Council as a "conduit through which cost-cutting recommendations can be disseminated to every echelon of the Department." This real interest being shown in productivity improvement on the part of the uppermost levels of DOD management appears to be a source of motiviation to employees and managers involved in productivity-related work.

Furthermore the Air Force, Navy, and Army are engaged in their own productivity improvement activities. Although each service appears to be making substantive progress, our most in-depth look at these efforts so far has been with the Air Force Productivity Enhancement Program. A most vital and effective part of this program is the policy that allows savings achieved from productivity improvement to be applied to other approved but deferred activities within the organization responsible for the savings. This is seen by the productivity staff as the best way to motivate Air Force middle managers to work for savings. This approach also overcomes the notorious disincentive to productivity encountered by most managers, namely budget reductions that match any previous savings.

An example of Air Force savings achieved by increased productivity is seen in the results of the Fast Payback Capital Investment Program. In 1980–81, 275 projects were initiated under this program with estimated life cycle savings of more than $60 million. The Air Force claims a return on investment of seven-to-one for these projects.

Another important Air Force initiative is the Integrity and Management Program which was recently established by the Secretary of the Air Force as a counterpart to the DOD-wide Council. One of the main objectives of this program is to closely coordinate the activities of the Productivity Enhancement Program with such other initiatives as the value engineering and acquisition improvement programs.

Another Federal organization that has made considerable progress in productivity improvement is the Internal Revenue Service where a newly created Planning and Analysis Division is the focal point for the already existing productivity program. Two important projects run by the productivity staff are the Productivity Enhancement Fund and the Management Generated Savings Program. The former provides funds for various productivity improvement projects within the Service. The latter has a payback incentive which allows managers to keep 50 percent of the savings generated by improvement projects. The Service's fiscal year 1982 productivity plan listed 215 productivity-related projects of all kinds. The plan reported a savings of almost $27 million for fiscal year 1981.

I should note that officials with these productivity programs and several others we have examined spoke highly of the Office of Personnel Management's Workforce Effectiveness Division's efforts in helping them initiate, implement, or improve

their programs. OPM's program, which began in 1979, was designed to assist Federal managers in improving productivity through management analysis, improved measurement, and information sharing among managers in the Federal Government and the private sector as well. These officials are concerned that this support from OPM has been virtually eliminated and they now lack any central support and assistance. Many productivity officials believe the elimination of OPM's support may hinder their agencies' efforts to develop and improve effective productivity improvement programs.

Although we are able to point to several positive actions for productivity improvement in the Government, we are concerned that not enough is being done. We have found in many of our studies that Federal managers in general are not particularly cost-conscious. This is not entirely their fault since there are at least two obstacles to productivity improvement. First, we have found that a common ingredient in achieving improved productivity in the Government is the willingness of managers to take risks. We have heard of instances where risk-taking managers have been penalized or punished for taking such risks. We plan to follow-up on this point in our ongoing review. Second, the Congress, the administration, and the public are overly concerned with control. Some control is obviously necessary, but we have gone so far in trying to prevent every conceivable abuse in government, to avoid every mistake, and to look and be correct on every occasion that we have effectively suppressed efforts to improve productivity.

This means, for example, that as long as benefit checks are paid on time and accurately, a Federal manager is considered to be doing a good job. Seldom is anyone in the Congress, or the executive branch concerned with whether the same level of service could be provided at less cost. Understandably, most Federal managers respond by putting little emphasis on this area. We would like to see productivity and efficiency concerns made a high priority in Federal agencies. This is especially appropriate in a time of inflation and budget reductions that force managers to do more with less. Productivity improvement will allow agencies that have had budget reductions to do more than their reduced budget levels would suggest they can do. Thus, productivity is a most important management tool particularly in time of tight budgets. However, we lack approaches that will hold Federal managers accountable for productivity improvement and assist managers who want to improve productivity.

As we noted in a 1978 report (FGMSD–78–33), the Congress can help foster increased concern about productivity by encouraging agencies to use productivity data in their budget requests and by then using this data in the appropriations process. The Office of Management and Budget could also do much more along these lines.

Further, there should be some form of central management assistance to Federal managers who want to improve the productivity of their organization. We are concerned that each effort along these lines in recent years has been drastically changed or dismantled before having a chance to demonstrate results. Assistance for management improvement and productivity has shifted from OMB to the General Services Administration to the Office of Personnel Management. OPM's program has been virtually eliminated just as it was getting up to speed. While there are certainly other ways to reach the objectives OPM had set for itself when it created this productivity assistance effort, we have not seen any significant alternative Government-wide strategy put forth by the administration. Frankly, we are puzzled by this apparent deemphasis on productivity during a period of budget reductions. Federal managers need some help in reaching the productivity goals we believe they should be striving for, and that will enable them to produce despite reduced funding.

We consider productivity in the public sector to be every bit as important as it is in the private sector. We have seen that when given the necessary incentives and resources public managers can be extremely efficient in carrying out the public's business. Unfortunately, as I have already noted, the Congress and OMB are often more concerned about effectiveness and overall budget levels than about agency efficiency. The current budget reductions are placing severe demands on many Federal managers; this environment of austerity should be used to nurture increased concern about productivity. This has been the intelligent response of many private firms that have confronted financial constraints, and it has been the response of some Federal managers. It must be made clear to Federal managers at all levels that productivity is a matter that deserves to be of high priority and that they will be held accountable for the productive utilization of resources. We simply cannot afford not to pay more attention to productivity improvement.

Mr. LAFALCE. Thank you, Mr. Usilaner, and rather than question you now, I think we will turn to the testimony of Mr. John Stepp, the director of the Office of Labor-Management Relations Services, within the Labor-Management Services Administration of the U.S. Department of Labor.

Mr. Stepp, we will introduce the entire text of your remarks in the body of the record and you are free to give them or summarize them, as you wish.

TESTIMONY OF JOHN R. STEPP, DIRECTOR, OFFICE OF LABOR-MANAGEMENT RELATIONS SERVICES, LABOR-MANAGEMENT SERVICES ADMINISTRATION, U.S. DEPARTMENT OF LABOR, ACCOMPANIED BY DONALD DOTSON, ASSISTANT SECRETARY FOR LMSA, AND RONALD ST. CYR, DEPUTY ASSISTANT SECRETARY, LMSA

Mr. STEPP. I am pleased to have this opportunity to participate in these oversight hearings on productivity. I would like to point out that as evidence of their interest and support, Donald Dotson, the Assistant Secretary for LMSA, and his deputy, Mr. Ronald St. Cyr, have been with us for at least a portion of the hearings and I think Mr. St. Cyr is still present.

American businesses which involve wage earners in workplace decisionmaking not only confront the present productivity crisis with far greater strength, they also create a decided edge in seizing the opportunities of the future. As Secretary Donovan recently pointed out in remarks before the Building Trades Department of the AFL–CIO, and I quote:

> Every experienced worker knows things about his or her job that no management design can capture. It is an invaluable asset that American business has been ignoring and neglecting for years. Now we are becoming aware of it, but management still has a long way to go in enlisting the full cooperation of its workers.

To accomplish this, management must be willing to accept employees, in Secretary Donovan's words, "as fellow producers, as full-fledged partners in the productive process" who share with it a mutual interest in securing the future of the firm and of the jobs it provides.

American businesses are beginning to recognize this. Interest in labor-management cooperation as a constructive alternative to confrontation is growing rapidly. Assistant Secretary Donald L. Dotson, testifying on the Labor-Management Services Administration budget just this past Friday stated that cooperation must replace confontation if real productivity is to take place in industry. The success stories that I am sure will be outlined during these hearings reflect what is happening at hundreds of firms across the country and many more are considering undertaking cooperative efforts.

Small businesses have been in the forefront in implementing cooperative programs. Of the more than 360 active cooperative labor-management programs identified by the Labor-Management Services Administration, LMSA, since we began our systematic analysis of this, over half are small businesses employing fewer than 500 workers; two-thirds employ less than 1,000 workers.

Since small businesses tend to be more labor intensive than larger firms, they especially have a great deal to gain from tapping the problem-solving capacity inherent and readily available among their employees.

Yet for small businesses to be able to take full advantage of this opportunity, they must have access to sound information. Processes used to involve workers in decisionmaking vary widely. In the past few years, they have come to include quality of worklife programs and quality circles, as well as the more familiar labor-management committees and gainsharing plans that Mr. Usilaner just spoke of.

Many companies are rushing to implement programs which seem to offer instant remedies or panaceas for their productivity woes. However, ill-advised or ill-prepared initiatives may lead to program failures and prove to be ultimate setbacks for some firms. Companies need to be aware of the importance of advance preparation and diagnosis. They must first carefully analyze or assess the readiness of their organization, the state of their labor-management relationships, the resources they are prepared to commit and the overall business climate in which they find themselves, before undertaking efforts requiring substantial changes in managerial policy.

They also must identify the range of alternatives available before they can adequately evaluate which program or process is appropriate to their circumstances. Wage earners, as well, need to evaluate carefully their relationships with management and understand the alternatives available before they can make well-reasoned decisions about joint undertakings. This is the sort of comprehensive analysis that will provide a sound basis for long-term success for all concerned.

The Department of Labor, through LMSA, has begun to address this most serious matter. We are attempting to stimulate interest among business and labor leaders to reexamine their old ways of relating to one another and to explore less adversarial methods in order to stimulate productivity advances and improve the quality of working life. We are stressing the importance of diagnosis and organizational readiness before companies begin hasty efforts to implement. We intend to provide interested parties meaningful information of the array of cooperative options so they can assess the appropriateness of each to their particular circumstances.

Given our resources, we seek to accomplish this by working with and through trade associations, international unions, and regional resource centers such as State productivity or quality of work life centers and area labor-management committees. To the greatest extent possible, we wish to assist in the establishment of an indigenous capacity in these institutions to reach and serve a far broader constituency than we could ever hope to serve directly.

If this information service and technical assistance capability could be created in trade associations and international unions, then all employers and locals in that industry could potentially benefit. Similarly, if that capability could be provided to regional centers, all employers and employees serviced by those centers could avail themselves of this information and assistance. Although we are only in our startup phase, we have to date made presentations at the annual conference of Steel Container Manufacturers

and at the Rubber Manufacturers Association's Conference. These presentations resulted in requests from a number of firms for Department of Labor assistance in exploring further their options for initiating cooperative programs. LMSA is following up on these requests.

LMSA has as well provided technical assistance to business and labor organizations to further their efforts in this area. We helped the International Association of Machinists design a survey for its locals which profiled its membership's involvement in cooperative programs. This has increased the machinists' leadership's awareness of the extent of its members involvement and has indicated directions the international might take to encourage and assist its members efforts.

LMSA is now encouraging other unions, such as the Clothing & Textile Workers, to do similar profiles. We also helped the George Meany Labor Studies Center of the AFL–CIO develop a recent seminar on labor-management cooperation for labor leaders. We also are discussing with the Communications Workers of American and the Food and Service Trade Department of the AFL–CIO projects they may undertake.

LMSA plans to publish, subject to budgetary constraints, a "User's Guide to Labor-Management Cooperation," a directory listing examples of cooperative inplant efforts between labor and management. The guide would promote those efforts by stimulating exchanges of information among current and potential practitioners. This directory would be the most comprehensive listing published on cooperative labor-management programs. Hundreds of companies, unions, and public agencies across the country have provided information on their programs. Business and labor people would be able to locate programs in which others in their region, industry, or unions are involved. By encouraging these direct contacts, the guide would have the capacity to stimulate the development of the most valuable network of information and support that could be established among those interested and involved in cooperative labor-management programs. We are working to develop an ongoing program to provide this type of information that will be the center of our clearinghouse function.

LMSA has developed a strong liaison with many of the present 28 area labor-management committees in the country.

Mr. LAFALCE. Mr. Stepp, I am going to have to interrupt you, since we will have the entire text of your remarks in the record at the end of your oral testimony, since the bells have rung indicating that there is a vote on the floor of the House.

With this interruption, I would just like to ask you a few questions.

Mr. STEPP. Sure.

Mr. LAFALCE. Then we will have to recess.

Is it fair to say that your office is the essential office in the Federal Government for information, advice, and guidance regarding what is generally referred to as human resources productivity?

Mr. STEPP. I would say that that is a fair statement, provided it were limited to the human resources component in the productivity equation.

Mr. LAFALCE. Brian, do you want to comment on that?

Mr. USILANER. Well, as you well know, John, there are other activities in the Department of Labor, and one of the problems we found, was that there was no overall departmental focal point when we did our study.

Mr. LAFALCE. You called for the creation of the Human Resource Administration, did you not?

Mr. USILANER. Well, at least a designation of the leadership role within the Department, which there was none.

Mr. LAFALCE. Do you feel as it now stands there is no adequate definition of a leadership role in the Department of Labor?

Mr. USILANER. In the Department, yes.

Mr. LAFALCE. Well, what other agencies, offices, or administrations do we have within the Department of Labor which interfaced with Mr. Stepp's office, which create confusion as to who has the leadership role within DOL?

Mr. USILANER. As you all know, the Bureau of Labor Statistics does a lot of work in the productivity area. The Office of the Assistant Secretary for Policy, Evaluation, and Research conducts a periodic quality of working life survey, and funds certain research concerning human resource productivity efforts; these are some examples. There are pockets of work definitely going on in the Department. But there was just no plan, no overall objectives, no prioritizing of their work, and no overall coordination and direction.

Mr. STEPP. Mr. Chairman, that December 1980 GAO report pointed out, I think, many of the shortcomings in the Department's approach, particularly how the efforts had been so fractionalized among agencies within the Department. In part, what we are about in LMSA is to address that problem and to try to bring some sense of focus to it. LMSA is certainly taking a leadership role within the Department in trying to be that focal point.

Mr. LAFALCE. I think what we ought to do, Jim, is to communicate with Secretary of Labor Donovan, asking him to comment on the actions taken by DOL since the December 1980 report to implement the recommendations of that report. Certainly, the report coming in December 1980, and Secretary Donovan coming in January 1981, we have a clear delineation of past behavior and present behavior of this administration. I think it is probably better that we send it to him than to your office.

Now, what do you do with labor-management committees and what does the Federal Mediation and Conciliation Service do with labor-management committees, and how do you interface?

Mr. STEPP. OK. Before coming to the Department of Labor, I was at FMCS. In fact, I headed up those preventive mediation programs. The Federal Mediation Service right now is primarily involved with labor-management committees, through the Labor-Management Cooperation Act of 1978, providing grants to a very limited number of——

Mr. LAFALCE. How much money do we have in that now for fiscal 1982?

Mr. USILANER. Isn't it $1 million?

Mr. STEPP. I thought in 1982 it was reduced to half a million dollars.

Mr. LAFALCE. What about in 1983?

Mr. STEPP. I don't think any moneys have been appropriated, to my knowledge.

Mr. LAFALCE. So, this administration is going to call for the elimination of Federal funding for labor-management committees?

Mr. STEPP. I am not qualified to speak to that.

Mr. LAFALCE. Well, Brian, I am going to ask you to call us this afternoon or tomorrow with that information. OK?

Mr. STEPP. We have been working in my office very closely with the National Association of Labor-Management Committees. We will be cosponsoring a symposium this June on this subject where we hope to bring top people from business, labor——

Mr. LAFALCE. Where will that be?

Mr. STEPP. It will be at Airlie House just west of here at the conference center near Warrenton, Va. We think that it is going to be a very important forum for us to decide the kinds of things that are needed to be done, both by business, labor, and Government.

Mr. LAFALCE. That will be interesting. Please keep me abreast of that, and I may either attend myself, or send staff to attend. In any event, I would like to continue this, but unfortunately, I have to leave immediately for a vote on the floor of the House and my schedule precludes returning. We will follow this up with some written questions. We will leave the record open until that point in time.

[The prepared statement of Mr. Stepp follows:]

PREPARED STATEMENT OF JOHN R. STEPP, DIRECTOR, OFFICE OF LABOR-MANAGEMENT SERVICES ADMINISTRATION, DEPARTMENT OF LABOR

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To accomplish this, management must be willing to accept employees, in Secretary Donovan's words, "as fellow producers, as full-fledged partners in the productive process" who share with it a mutual interest in securing the future of the firm and of the jobs its provides. American businesses are beginning to recognize this. Interest in labor-management cooperation as a constructive alternative to confrontation, is growing rapidly. Assistant Secretary Donald L. Dotson, testifying on the Labor-Management Services Administration budget on March 19, 1982 stated that cooperation must replace confrontation if real productivity is to take place in industry. The success stories that I am sure will be outlined during these hearings reflect what is happening at hundreds of firms across the country. And many more are considering undertaking cooperative efforts.

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work life (QWL) programs and quality circles, as well as the more familiar labor-management committees and gainsharing plans. Many companies are rushing to implement programs which seem to offer instant remedies or panaceas for their productivity woes. However, ill-advised or ill-prepared initiatives may lead to program failures and prove to be ultimate setbacks for some firms.

Companies need to be aware of the importance of advance preparation and diagnosis. They must first carefully analyze or assess the readiness of their organization, the state of their labor-management relationships, the resources they are prepared to commit, and the overall business climate in which they find themselves, before undertaking efforts requiring substantial changes in managerial policy. They also must identify the range of alternatives available before they can adequately evaluate which program or process is approriate to their circumstances. Wage earners, as well, need to evaluate carefully their relationships with management and understand the alternatives available before they can make well-reasoned decisions about joint undertakings. This is the sort of comprehensive analysis that will provide a sound basis for long-term success for all concerned.

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LMSA has developed strong liaisons with many of the present twenty-eight area labor-management committees in the country. Labor and business leaders in a number of regions facing economic decline have formed these committees to pro-

mote their area's economic development. One of their primary tools is development of inplant labor-management committees to improve the local labor relations climate.

Many area labor-management committee (ALMC) members are owners of small businesses where cooperative programs have been implemented. The ALMC provides a vehicle for this experience to be shared. In addition, it provides a means for local business and labor to concentrate their joint resources on developing labor-management training and similar programs that can be used by local businesses. The area labor-management committees at Jamestown and Buffalo, New York, are outstanding examples of how this potential has been utilized. Both have been responsible for the development of numerous successful in-plant labor-management committees.

LMSA is considering publishing several studies dealing with area labor-management committees and inplant labor-management committees. One is a study of the impact area labor-management committees have on the labor relations climate for economic development in their regions. Another study takes a look at the dynamics of labor-management committees and analyzes their impact on the organizations within which they operate. LMSA is also considering publishing "Lessons From Three Years of Assisting Union-Management Quality of Work Life Programs" by Michael Brower, Executive Director of the Northeast Labor Management Center.

Through its clearinghouse function, LMSA is responding to the rising demand for information on labor-management cooperation. Sources of such requests include quality of work life and productivity centers which serve businesses and labor in their regions, State and local governments, area labor-management committees, companies, and unions. LMSA is building its capacity to provide to this audience, on a regular basis, information on current publications, films, other related materials, and local sources of technical assistance. Also being planned is a calendar of public conferences and seminars on labor-management cooperation.

Plans for a spring symposium on labor-management cooperation and productivity are being developed by LMSA. Our goal is to bring together a small number of very highly qualified representatives from business, labor, academia, and government to share experiences and to explore jointly ways to improve productivity and quality of work life.

Within the LMSA structure itself we have introduced participation circles, a process through which employees in a unit meet weekly to identify and resolve workplace problems. The program has been presented to members of management and volunteer offices have been sought for pilot circles. Participation circles are now operating at the Philadelphia Regional Office. LMSA has developed participants' manuals and other training and program materials and is providing knowledgeable circle facilitators from its staff. The expertise and information resulting from implementation of this program will be used in LMSA's outreach efforts as well.

Though its cooperative labor-management programs were only recently formed, LMSA has acquired considerable experience in its efforts to satisfy the growing demand for expertise in the development of cooperative programs.

The National Productivity Advisory Committee, recently formed by President Reagan, is addressing, through its four subcommittees, issues of critical importance to American workers. With Under Secretary Malcolm Lovell as its liaison to the Human Resources Subcommittee, the Department of Labor is assisting the Productivity Advisory Committee's efforts to deal with those critical issues.

Mr. Chairman, this concludes my statement. I will be happy to answer any questions you or members of the Committee may have.

Mr. LAFALCE. The subcommittee will recess until tomorrow morning at 9 o'clock.

Thank you.

[Whereupon, at 12:11 p.m., the subcommittee adjourned, to reconvene the following morning, Wednesday, March 24, 1982, at 9 a.m.]

PRODUCTIVITY

WEDNESDAY, MARCH 24, 1982

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SMALL BUSINESS,
SUBCOMMITTEE ON GENERAL OVERSIGHT,
Washington, D.C.

The subcommittee met, pursuant to notice, at 9:30 a.m., in room 2359-B, Rayburn House Office Building, Hon. John J. LaFalce (chairman of the subcommittee) presiding.

Mr. LAFALCE. The Subcommittee on General Oversight of the House Small Business Committee will come to order.

OPENING STATEMENT OF CHAIRMAN LaFALCE

This morning we will resume the hearings we began yesterday on the issue of productivity. For those of you who weren't here yesterday, we had Mr. Joji Arai, the manager of the United States office of the Japan Productivity Center; Mr. Brian Usilaner, director of the National Productivity Group of the U.S. General Accounting Office; and John R. Stepp, Director of the Office of Labor-Management Relations Services in the U.S. Department of Labor.

This morning we are going to have two panels. The first panel will consist of Mr. Bernard Sallot, the executive director of the Robot Institute of America and the director of professional and government relations for the Society of Manufacturing Engineers. We will also have Mr. Egils Milbergs, the Director of the Office of Productivity, Technology and Innovation, U.S. Department of Commerce.

The second panel will consist of Dr. David Clifton and Mr. Sherman Dudley of the Georgia Productivity Center, and Mr. Mitchell Fein, president of Mitchell Fein, Inc., in New Jersey.

Will the members of the first panel please come to the witness table? Mr. Sallot and Mr. Milbergs.

Mr. LAFALCE. Mr. Sallot, I would ask you to give us your testimony first.

PANEL CONSISTING OF BERNARD M. SALLOT AND EGILS MILBERGS

TESTIMONY OF BERNARD M. SALLOT, EXECUTIVE DIRECTOR, ROBOT INSTITUTE OF AMERICA, AND DIRECTOR, PROFESSIONAL AND GOVERNMENT RELATIONS, SOCIETY OF MANUFACTURING ENGINEERS

Mr. SALLOT. Thank you, Congressman.

According to the letter and the instructions I received for this hearing, it is a large order I am supposed to handle in 10 minutes or less, but I will try to do it.

Mr. LAFALCE. Take longer, if you would like.

Mr. SALLOT. Thank you.

I don't have a prepared statement, because of the time element, but I think I can speak from my notes fairly well to your subject.

First of all, I will deal with robotics, and its relationship to productivity in the United States. I think we have to define, first of all, what we mean by a robot. A robot is not "Star Wars," or the android, and it is not the exotic. It is a piece of equipment that can duplicate a human's activities. It is infinitely reprogramable from one operation to another, and is designed to move materials and parts between operations and to help assemble components within themselves. It is a sophisticated machine tool, and it can operate with machine tools.

Just a few words about the history of robotics. In the United States, robots were conceived and manufactured entrepreneurially by small business companies over a 35-year span. Individuals put together certain technical disciplines that we already had electronics—just emerging—pneumatics, hydraulics, and certain mechanical elements to build a piece of responsive equipment that we now call a robot. These robots duplicated human activities, reaching as they do today seven axes of movement. Axes are movements, such as elbow, shoulder, body pivot, up and down it.

The fledgling industry received no acceptance because the technology received no acceptance. It is to the credit of these pioneers that they continued their efforts. However, we pay for that today. When the U.S. industry didn't accept and use the technology in order to survive, the manufacturers turned overseas. As a result, our technology became available to the Japanese, and a little later the Europeans. Both were able to do what they do so well; namely, apply that technology to their own operations and develop it.

We say that many times the Japanese are not innovative. I think that is an untrue statement. They are very innovative in taking over technology and applying it to their own operation. Innovativeness covers that whole span of technology, not just the generation of the original idea, or the technology. I now speak in the role of a technical society, the Society of Manufacturing Engineers which currently has about 63,000 members worldwide, and covers all phases of industrial production.

Mr. LAFALCE. You wear two hats.

Mr. SALLOT. Yes.

Mr. LAFALCE. Will you explain to me what you do with one hat, and what you do with the other hat?

Mr. SALLOT. The Society of Manufacturing Engineers is a 63,000-man society in some 60 countries around the world, and has about 240 chapters in the United States, including about 7,000 student members.

Mr. LAFALCE. Is that just in the American society, or is that in the worldwide society?

Mr. SALLOT. Pardon?

Mr. LAFALCE. Are you head of the worldwide society, or just the U.S. society?

Mr. SALLOT. We have only one headquarters, which is based in Detroit, for our worldwide operations. I am not the head of the society.

Mr. LAFALCE. You are the director of professional and government relations?

Mr. SALLOT. For 17 years, I have been with SME. I did set up, when we were a very small organizations of about 35,000 members, all of their technical activities, nationally and internationally, and the subassociations which we have today, the Computer and Automation Society, and so forth. In 1974, I was charged by the society to found the Robot Institute of America, which is a separately incorporated trade association, incorporated in Washington, D.C. SME executed a management contract with RIA. So I serve as the executive director of the Robot Institute of America, that is as the chief staff executive, but I have collateral duties with the Society of Manufacturing Engineers. I have an independent staff that is dedicated to the activities of the Robot Institute.

It is a rather unique situation. We tend to combine, I think, the best of both worlds. We have the trade association which can promote the growth of the technology and the industrial base; and we have the professional society which is composed of those engineers, technicians, and professional people who use the technology and are desirous of learning it. We merged the best of both worlds, I think. Where we are today is on the threshold of a major use of robotics.

I don't like to talk—as do many of our members—about the use of robotics alone, because robots are the end-effector of a system, an entire system that is perhaps computerized, uses microprocessors, and handles a product through various processes in industrial operations. The end result is that the robot does something. It is not mostly any more a stand-alone piece of equipment bought and used on a random basis.

To illustrate why I think we are on the verge of a major use of robotics, 2 weeks ago in Detroit we had our Seventh Annual Conference on Robots. We expected about 450 engineers, executives, and so forth to attend the conference. Two weeks before it began, we had 2,300 registered and paid. We expected about 12,000 to view the products of about 110 exhibitors, and we wound up with about 34,000 people coming through the exposition, about half of which—and I think this is significant—were the general public. We don't normally encourage the general public to educational shows, or trade shows, if you will.

About 90 percent of the people that came through were new to the technology, both from the conference standpoint and from the exhibit standpoint. That is significant because it means the robot people are not talking to themselves. They are not exchanging one idea with "Brother Joe" down the street. There are new people and entities coming into the market.

The list of companies they represent probably included about 75 percent of the Fortune 500 in the industrial sector. For instance: IBM had seven vice presidents at the show, the chairman of the board of General Electric came as did the chairman of Westinghouse. Those were the type people in attendance. They are the people that when they say, "Go," something moves.

We have many problems at present with the use of the technology. We have some opposition by the general public, though I don't think that is great. The opposition on the part of labor has been hyped, I think, out of all proportion by the media at the operating level. At the executive level, there is not all that resistance to the installation of robots or automation technology.

Mr. LAFALCE. I just sense a general awareness on the part of labor that the introduction of robotics is inevitable. As a matter of fact, I sense in my conversations with them a desire to see their companies introduce robots as a sign of the future stability and competitiveness of the companies. I might be wrong, but I really think that we have a strawman when we talk about the vehement opposition of labor. To be sure, there is some, but I don't sense it as great at all.

Mr. SALLOT. This is the impression, Congressman, I would like to leave with this group, because you are absolutely correct. Within the Society of Manufacturing Engineers, we have a substructure which we call Robotics International. There are about 6,000 engineers and technical persons involved as members, who are interested primarily in robots. It has its own board of directors. Don Ephlin, who is the vice president of UAW for Ford, one of the major UAW executives, has been a member of the Robotics International board for about a year. He has worked very closely with us to discuss the impacts of the technology. I like the informality of this exchange, because I am perhaps answering the things you want to know. The informality may tend to throw me a little bit off from my notes, but if you don't mind, I don't either.

We are about to issue a position paper dealing with the social impact of robotics. We have discussed it with the UAW, other people, and other unions, including industrial people, industrial executives, and so forth. It deals with the displacement of people, and not the replacement. It deals with the need for retraining, the need for upgrading skills, and it deals also—I think it is very significant—with the replacement rate. No matter how we gage it, if you take the wildest dreams on how many robots could be built and installed in the next, 8 years, let us say, by 1990, you find that the attrition rate is a little more than twice that rate of installations. In other words, just people deciding to change jobs, to leave of their own accord, or die, is twice the production you could accommodate. The production is less than half of what that attrition can cover.

Then, if you look at the market for these products—not only of robots, but of automation—you find that your primary markets are those industries and companies covered by very strong seniority agreements, so that a highly paid, highly skilled man who might be replaced by some automation does not hit the street. I mean there is a progression of jobs, and somebody just doesn't get hired at the end of the line. So the displacement is minimal.

We thought that was a significant factor, because the media and everybody else feels that you are just going to replace people in industry, and that there will be a net loss of jobs.

Mr. LAFALCE. How many robots do we have in the United States today?

Mr. SALLOT. About 6,000.

Mr. LAFALCE. How many are we going to have in 1990?

Mr. SALLOT. About 125,000.

Mr. LAFALCE. Which companies should we invest our money in, who are going to produce all of these robots?

Mr. SALLOT. I don't think I should answer that question. [Laughter.]

Very frankly, in today's climate, unless it were one of the major companies that is well capitalized. I think some of the smaller pioneers are in danger. The country, certainly, is working hard to stop inflation, an objective which is certainly highly endorsed. We are creating incentives for small business and industry to innovate, to modernize, and to regain our productivity, but I think our timetable is out of whack. We are doing all these nice things, but our bankruptcy rate is going up, and our small firms are hanging on by their fingernails. If they want to innovate, if they want to modernize, if they want to be competitive, particularly in the robot industry, they can't get the money to do it with, and if they could get it, they can't afford the interest rates.

Mr. LAFALCE. This is a very serious problem. First of all, I think that we have got to see the trend between now and 1990, which you forecast, and I hope that comes to pass. I think it has to come to pass if we are going to become internationally competitive, remain internationally competitive, and enhance that competitive posture.

There are a number of things that concern me, primarily for the purpose of this hearing, the ability of small business to capitalize on the introduction of robotics into the American industrial setting, and the effect it will have upon small business if small business is unable to have access to robots. I am fearful that right now, small businesses will not be able to introduce robotics into their work setting, and I don't see that changing in the future unless there is some targeted program to help bring that about.

Mr. SALLOT. Speaking on that point, it is a course, obviously, that can't be too simple. The small business people simply cannot afford to use the technology.

Now, I just got through mentioning the overwhelming statistics of a meeting 2 weeks ago showing interest in the technology. Obviously, those people don't come unless they are interested, unless they want to do something. Guess what? The rate of order placement and the rate of product shipment in the robot industry is actually declining at the present time. People cannot get the money to fulfill their commitments, and they can't see a stable enough economy ahead even to make commitments.

We have, right now, major robot manufacturers in the United States. As exotic and accepted as the technology is, one of these has shown a $1,900 profit for his first quarter of this year, versus half a million last year. He is a small manufacturer. Under normal circumstances you should get about $2 million profit a year for this small businessman. He has to live, modernize, research, put people out in the field and expand on a profit of $1,900 for last quarter, and he is currently witnessing a slowdown of his orders. Expansion, even survival, under these circumstances is doubtful.

This is a technology that people are accepting, our Government is accepting, our defense people are accepting, our industries are accepting. Where are the orders?

There are many reasons for it. We seem to be embarked on a program of killing inflation, and I think we are using three methods at one time. Maybe this is facetious, but you can lick inflation by bringing the gross national product down to zero, then you don't have anything to inflate.

Mr. LAFALCE. That is what we have been doing this past year.

Mr. SALLOT. Or can kill inflation by not giving the consumer any money to spend, or you can kill the industrial base so there are no products to sell, so you have no inflation. It seems that we are trying all three of them at one time. I think that is the root of the problem. The small businessman in the United States has gone on for years trying to innovate and to survive, and a goodly percentage of them are satellites of the industries that are basic to us and which are being killed off.

Mr. LAFALCE. What is the composition of the Robotics Institute of America? Now, my guess is that it is primarily very large businesses.

Mr. SALLOT. No; that is not necessarily true. We grew from 1974 with 3 manufacturers, 5 corporate users, and 2 research people, to where today we have about 225 companies, 183 corporate users, and have over 35 manufacturers, large and small. The manufacturers include all the way from larger General Electric to little Armax out in Farmington Hills.

Among the corporate users, there are some small shops, but some are very large: Xerox, Ford, General Motors, and so forth. By the same token, there are some medium-size businesses such as Budd Wheel, and you can go all the way down to the companies in the $5 million to $10 million class. We even have one fellow that has about $900,000 worth of sales a year, he is thinking about a robot, and he is in the institute.

Mr. LAFALCE. I think I need to hear from you in the future, sir, about a program to help bring robots to the small business sector of America. If we don't hear from you about that, I am fearful we won't see small business using robots, and it might lead to the extinction of those small businesses in the future.

We heard from a representative of the Japan Productivity Center yesterday, and they have very aggressive programs on the part of both the National Government and the municipal government and large businesses to transfer robots, computers, and so forth to small businesses.

Mr. SALLOT. Both in Japan and in the United States, and that is the significant thing. Joji probably told you that they have leasing arrangements over there where small businesses can get 5 percent loans.

Mr. LAFALCE. Yes.

Mr. SALLOT. In some of the outlying districts, the municipality will put up all the front money to bring a new technology just to create an industry in a given area.

By contrast, New York City buys $254 million worth of subway cars from Japan, against our own Budd Co. in the United States, the sole reason having nothing to do with cost, quality, engineering, or anything else, but the mere fact that our Government won't meet head to head in the financing terms with the Japanese Government to make us competitive. The Budd Co. certainly can't take

the role of the Government and assume low-cost 5-percent loans as Japan did to get the order. The philosophy that the entire matter is solely the concern of the private sector does not wash in this case.

Mr. LAFALCE. Well, it seems to me that you should be advocating something for the small business sector of this economy. You can't pass legislation, you can't take an administration position. But you can suggest policy changes and implementations.

Let us switch gears a bit: You mentioned job displacement or replacement. It seems to me one great need that we will have if we are going to have the introduction of robotics on a large scale without vehement opposition is much, much greater job retraining efforts. What is the Robot Institute of America doing to encourage this from the Federal and State Governments? What is the Robot Institute of America doing to encourage this within institutional America, the large corporations who perhaps can have some type of in-house job retraining programs?

Mr. SALLOT. First of all, we are working very closely with the State of Michigan, as we are with other States, in terms of looking at the problem and advocating retraining. The Robot Institute of America has a budget of less than $100,000 a year, so we don't have money ourselves to put into this. Remember, we are largely small companies. It is only recently that large companies have become involved.

We have been working for several years with the State and National Governments advocating retraining programs, and the redirection of existing funds already being used for retraining the people to the new skills. There are some obstacles, of course, because the Department of Labor has yet to recognize in its industrial classifications such entities as automation, robotic technicians, and classifications of this nature.

Mr. LAFALCE. Would you repeat that, please?

Mr. SALLOT. I said that the Department of Labor has yet to officially acknowledge in its list of job classifications some of the new classifications which you have to retrain people for. This restricts the ability of the people who train in those areas to secure available Government funds for that use.

Robots in some areas are replacing people in welding operations, so there exists a surplus of welders, yet the State and Federal Government programs are still training new welders. It is a problem that needs to be looked into. The Department of Labor tell us that they have a 2- to 3-year to maybe a 5- to 8-year lagtime before they can accept a new classification for training. That does not seem to mesh with the current rapid progress of technology nor does it help.

Mr. LAFALCE. Do you know of any joint task force between the Federal Government, the Council of State Governments and industry to determine what job retraining efforts are needed in the 50 United States?

Mr. SALLOT. There has been a lot of work done in that area. Both the UAW and the machinists union have sponsored large numbers of programs. In our own organization our education department—which I am not that familiar with—has worked with many institu-

tions, some in the Federal Government, to look at the problem of retraining. I could furnish these to you on a followup.

There was an announcement in the paper the other day about a $300,000 grant from the Federal Government to the UAW and, I guess, somebody in the automotive industry. They asked $1.7 million to retrain, and they got $300,000. It fell short of what was really needed, but certainly it was a step in the right direction. That was in the paper just the other day about a cooperative grant. We have been talking for years about the need for retraining.

Mr. LAFALCE. Everybody talks and talks and talks. That means nothing that you have been talking for years. What are we doing?

Mr. SALLOT. But, you know, when you talk, somebody has to listen. I think our problem has not been people who have been unwilling to talk, I think it has been people who have been unwilling to listen.

Mr. LAFALCE. What, specifically, have you asked for? Have you come out with a specific program? Is there anything concrete, or tangible? Do you have a position paper?

Mr. SALLOT. There were two position papers we issued early last year and distributed to all the Members of Congress and all the agencies that dealt with the issue of productivity, low-cost loans, retraining, displacement, the relative position of Japan and the United States, all these things.

Mr. LAFALCE. Do you have copies of these with you?

Mr. SALLOT. I don't have copies with me, no. I can furnish them to you.

Mr. LAFALCE. We will leave the record open for the introduction of them, and we ask you to forward them to us.

[The material referred to above appears in the appendix of today's hearing.]

Mr. SALLOT. They were introduced in the record of the Committee on Science and Technology last July. They were introduced to the OTA workshop proceedings on whether or not there should be a definitive study on the whole area of robotics, also last July. As a matter of fact, I just received a report the other day on that OTA workshop, which I think was very fine. There was a lot of good material introduced there that dealt very heavily with the training issues, public policy issues, the role of industry, academia, Government, private sector, and so forth. I will be glad to furnish those things to you.

Mr. LAFALCE. Give me a list of those again, those documents that you were referring to.

Mr. SALLOT. We have one on productivity in general. The other one is on productivity in the United States relative to productivity in Japan.

Mr. LAFALCE. Is there anything on job retraining?

Mr. SALLOT. Yes; there is. It was mentioned in there.

Mr. LAFALCE. Did you say it was mentioned in one of the other papers?

Mr. SALLOT. It was mentioned in all of the papers we have ever issued.

Mr. LAFALCE. All right. There is not some separate document just on that?

Mr. SALLOT. No.

We have always considered job retraining as part of the problem.

Mr. LAFALCE. Yes.

Mr. SALLOT. We tried to anticipate the need for retraining rather than turn up with new technology, and suddenly have people ask, "Well, how do I run it?" We have tried to say as we introduced the technology that there should be some steps taken for retraining.

Mr. LAFALCE. Do any of your papers or documents call for special programs to assist small business in this "robot revolution"?

Mr. SALLOT. Yes, yes, it is in there, in terms of loans, assistance in retraining, the changeover of skilled people. One of the reasons that you have to be a little bit obscure on that is robotics is nothing more than a combination of things we already know: electrical, electronics, pneumatics, hydraulics, and so on. We just put them together in a different order to make the products of robotics.

I was on a talk show in Detroit on a minority station a couple weeks ago with Dr. Jefferson, head of the school system in Detroit. We spoke a little bit about education, and he asked me what the junior high and high schools in the Detroit system should be doing with regard to robotics. We reached a conclusion mutually that we should bring together the known engineering techniques and sciences and the four things I have mentioned, and simply orient them toward a piece of equipment known as a robot. Combine the basic technologies as they apply to robotics, in other words.

Mr. LAFALCE. Let us switch hats now and go to your Society of Manufacturing Engineers. You mentioned being on the air with the superintendent of schools in Detroit. I understand that we are now experiencing and will be experiencing a terrible shortage of engineers in American society, and that our educational institutions are simply not graduating the numbers of engineers required for us to be competitive in the future. Further, the education provided our students, on a primary and secondary level, in mathematics and sciences is grossly deficient, at least in comparison with the education provided to primary and secondary students in countries such as Japan and the Soviet Union. Has the Society for Manufacturing Engineers looked at this total picture and come up with any suggestions?

Mr. SALLOT. That is a very general question, Congressman.

Mr. LAFALCE. I just wonder if we need a National Defense Education Act similar to the post-Sputnik Act.

Mr. SALLOT. I don't think that would work. I really don't think that would work.

Mr. LAFALCE. What is the problem, as you see it, and what would work?

Mr. SALLOT. Well, the problem, of course, is the shortage of trained people in new technologies who are coming onstream. It's a long lead item. You don't suddenly take somebody who has been oriented in humanities, and when he comes to be a senior in high school, suddenly you say, "Hey, we are going to make you an engineer." It just doesn't work that way.

You have to go back to beginning education, and bring students into an engineering career. We figure you have to start at least shortly prejunior high to orient the student, or the potential student, and bring him down the path to become an engineer or a scientist.

As a society, I said we have about 7,000 students among our membership, and we have something like 126 or 127 chapters throughout the United States, all of which are on university campuses. We have developed curriculums which we call manufacturing engineering, and it puts together those basics which are needed for industrial processing leading to a degree in what we call manufacturing engineering. In other words, it isn't primarily electrical or mechanical training; it is a combination of those and others to make an all-around engineer.

There are probably about five universities now that give a degree in manufacturing engineering. There are about 110 or something that give an associate degree. This is mostly a political situation. The student gets the training, but the university can't acknowledge they are doing it as such.

The manufacturing engineers are coming out in increasing numbers. Engineers are coming out in increasing numbers generally. The only problem is that the speed of graduation is just not fast enough to meet the advances of technology. We are losing our teachers on campus at a tremendous rate. The situation in the education system is such that many of them have left for private industry. Our academia today can't meet the competitiveness of industrial salaries. So industry is draining off the very seed corn that we need to grow the engineers.

Mr. LAFALCE. Is there any type of program that American industry could come up with whereby it loans topnotch engineers to universities for 1 year, or 2, or 3 in some type of rotating basis and pay their salaries to provide the teachers that are necessary?

Mr. SALLOT. Some of the companies have done that already. General Motors has done it; TRW has done it. I could mention some other companies. There have been some cooperative programs with the University of Michigan.

You are seeing a lot of consortiums springing up. There are some very fine ones at Stanford, Purdue, the University of Michigan, et cetera. These are based on campus in a research atmosphere, and research applications atmosphere, some of it basic, and are supported by the industry in the area. There are six or more companies in the University of Michigan consortiums and they make a major contribution. Their engineers interface with the research people and the instructors on the campus. The university puts up some of the funding and supplies the personnel; the industry supplies both, and they trade back and forth.

One of the major advantages is that there is an orientation to the research. It is problem- or mission-oriented so that you are just not doing something that you may not use for 30 years and neglecting something that is needed next year. Those consortiums are starting to work out quite well.

Stanford, I think, has—Egils Milbergs here can probably correct me because he came from there—I think their consortium contains something like 20-odd companies and is fairly heavily funded in advanced technology, in things like vision, artificial intelligence, and so forth. MIT does the same thing. There is a high percentage of the instructors participating in these programs. You are probably getting the same effect of engineer aid coming out of company A

and going to the university campus, only you are getting it in an oriented and probably a faster atmosphere.

Mr. LAFALCE. Any other points that you want to make before we go to Mr. Milbergs?

Mr. SALLOT. I think one last point I would like to make is that robotics, as are most of the other technologies that are coming on-stream, such as microprocessors and vision, and so forth, are all struggling technologies at the present time. I think that we are going to lose the lead in these technologies, and we are going to lose the advantage of the use of these technologies unless we somehow, find or are able to create a forum where we can mutually discuss these problems and rapidly come up with some cooperative efforts, among Government, industry, academia, and the private sector.

It probably, in my opinion, was never more important to the economic future of this country that we do that, and do it soon. As you said before, we have all been talking and talking for years, but we have never come together on a forum. It was one of the reasons that I felt very strongly that the institute——

Mr. LAFALCE. What do you think of your counterpart? You are director of government relations for the Robot Institute of America, right?

Mr. SALLOT. That is one of my duties yes.

Mr. LAFALCE. When you think of the Federal Government, what office do you think of as the one that you have principal contact with, that is principally concerned with the issue of robotics?

Mr. SALLOT. We have worked for many years with the Department of Commerce. We are trying work with them now. We are somewhat handicapped by lack of funds and people.

Mr. LAFALCE. Is it Mr. Milsbergs' office or is it some other office?

Mr. SALLOT. Well, it is the Department of Commerce in general. If you talk export, for instance, we have another problem with the slowdown of the economy of the United States and no orders for robots. There are orders available from eastern bloc countries at the present time, and we find ourselves now on the verge of being restricted from selling there because some unfriendly group might get the technology. In fact, they can get technology through Italy, France, Japan or anyplace else. So, we work with the Department on that aspect.

Mr. LAFALCE. Well, I am thinking primarily of the introduction of robotics into the American workplace. Who do you interface with most? Is it Mr. Milbergs? Is it some other office?

Mr. SALLOT. Well, the export group down there, they change so much down there. We have a long history of working with the cooperative technologies program in the Department of Commerce, over the last 5 or 6 years, to get applied research centers set up similar to the Agricultural Extension Service to help small business. Finally, the law was passed, the program approved, and suddenly no money and no extension service.

Mr. LAFALCE. When was that law passed?

Mr. SALLOT. That was the Stevenson-Wydler Act. I think it was passed 1 year ago last October. It called for the implementation of technology centers throughout the United States to be funded by

industry and Government and to be phased out at the end of 5 years.

Mr. LAFALCE. Is that under the Department of Commerce?

Mr. SALLOT. Yes; it was. It is dead now.

Mr. LAFALCE. Mr. Milbergs, I would like the written report on the implementation of technology.

Mr. MILBERGS. On the Stevenson-Wydler Act?

Mr. LAFALCE. Yes.

[The information referred to above follows:]

ACTIVITIES OF THE OFFICE OF PRODUCTIVITY, TECHNOLOGY, AND INNOVATION IN IMPLEMENTATION OF THE STEVENSON-WYDLER ACT

The following is a status report on the implementation of the Department's responsibilities under the Stevenson-Wydler Technology Innovation Act (Pub. L. No. 96–480).

Sections 5(a) and 5(b) of the Act require the establishment of an Office of Industrial Technology, to be headed by a Level V Presidential appointee. The functions of the office will be performed by the Department's Assistant Secretary for Productivity, Technology and Innovation, and the Office of Productivity, Technology, and Innovation (OPTI) which now reports to the Assistant Secretary for Economic Affairs and which will be placed under the Assistant Secretary for Productivity, Technology and Innovation.

Section 5(c) calls for a broad range of complex studies on the relationships between technology/innovation and the U.S. economy, including our international trade. Sufficient studies exist on which to base policy decisions. Accordingly, no new studies are planned. OPTI is concentrating on developing specific action recommendations based on existing studies for consideration by top level policy bodies such as the Cabinet Council on Economic Affairs and the National Productivity Advisory Committee. Recently, OPTI has given attention to patent policy reforms, international technology transfer, and engineering education.

Section 6 calls for support to cooperative R&D ventures, identified as "Centers for Industrial Technology." While this program was originally funded for fiscal year 1981, such funding was rescinded by the Congress and no funds were requested or appropriated for it in fiscal year 1982 or fiscal year 1983. Because private sector cooperative R&D ventures are extremely important to the continued vitality of U.S. high technology industries, OPTI provides technical assistance upon request to private sector organizations wishing to form such ventures. Also, OPTI is planning a workshop to highlight the improved climate for cooperative R&D ventures, and explore the need for clarification of antitrust guidelines.

It is noteworthy that a number of cooperative R&D ventures are emerging without Federal funding, particularly in response to the effect of the new tax incentives. An example of a large-scale "for profit" cooperative arrangement is the proposed Micro-electronics and Computer Technology Enterprises which could involve $30–60 million per year. Prior to the recent announcement of this proposed cooperative venture, OPTI had worked extensively with the semiconductor industry regarding cooperative R&D approaches.

Section 10 requires the establishment of a National Industrial Technology Board (NITB) to advise the Secretary of Commerce regarding his Stevenson-Wydler Act responsibilities. Establishment of the NITB is under consideration.

Section 11(b) requires each Federal laboratory to establish an Office of Research and Technology Applications (ORTA), with laboratories having a total annual budget of over $20 million being required to assign at least one professional full-time to its ORTA. Section 11(b) also requires each Federal agency operating a Federal laboratory to devote at least one-half of one percent of the agency's R&D budget to technology transfer. Section 11(c) sets forth the ORTAs' functions. Section 11(d) establishes a Center for the Utilization of Federal Technology (CUFT) in the Department of Commerce with a variety of technology transfer functions.

Each laboratory of the Department of Commerce has established an ORTA and has identified a chief staff person for it. The National Bureau of Standards, the only laboratory within the Department with an annual budget of over $20 million, has assigned three full-time professional staff members to its ORTA. Each agency of the Department of Commerce operating a Federal laboratory devotes at least one-half of one percent of the agency's R&D budget to technology transfer.

Joseph Wright, Deputy Secretary of Commerce, testified on July 14, 1981 before the Subcommittee on Science, Research and Technology of the House Committee on Science and Technology that the National Technical Information Service (NTIS) will carry out CUFT's functions on a self-sustaining basis. The Administration's policy regarding technology transfer is to transfer as much information as quickly as possible when it is incidental to R&D work and can be done without appropriations. For technology transfer that is not incidental to R&D work and requires funding, recipients should pay the transfer costs through user fees. NTIS is receiving and marketing the "applications assessments" required to be prepared by each ORTA by subsection 11(b).

To assist in implementing Sections 11(c) and (d), OPTI has: (1) established close working relationships with NTIS, the Office of Science and Technology Policy, the National Science Foundation, the Federal Laboratory Consortium for Technology Transfer (FLC), the National Bureau of Standards (NBS) and the National Oceanic and Atmospheric Administration; (2) established an informal interagency network of approximately 15 Federal agencies involved in technology transfer, which recently specified November 1, 1982 as the date for the first biennial reports required by section 11(e); (3) started to develop a common approach for the content of those biennial reports; (4) established working relationships with several State and local government groups including the U.S. Conference of Mayors, the National Governors Association, and Public Technology Incorporated; (5) established an informal coordinating mechanism with the FLC to help process requests for technical assistance from State and local governments; and (6) initiated an identification of barriers to technology transfer from Federal laboratories to U.S. business.

Section 12 requires DOC to establish a National Technology Medal to be awarded by the President to companies or individuals. OPTI is assembling information on existing and past awards, as a basis for the development of nomination and selection criteria and other procedural details.

Section 13 requires DOC and the National Science Foundation (NSF) jointly to foster personnel exhanges among academia, industry, and Federal laboratories. The Department plans to meet with NSF in the near future regarding Section 13. The National Bureau of Standards already plans to increase its number of "Research Associates" by 100 over the next five years.

Mr. SALLOT. You could probably look at the one that somebody gave to Congressman Brown a year ago on why it wasn't implemented. Egils came in after that.

Anyhow, I think we need to find a forum. My main point was that the OTA is considering right now a study for Congress on all the phases of robotics, dealing with public policy issues, the needs, the retrainings, small business needs, and everything else. They tell me that it takes 18 months before a decision is made to even go ahead. I have difficulty understanding that. We had what I thought was a very fine workshop, well populated with experts, last July. I think that could well serve as the forum around which labor, industry, Government and academia could get together and come up with some concrete proposals on what to do about these.

I suggest that you support going ahead with that study. I guess [illegible] my point.

Mr. [illegible] We will look into that OTA study. I do have to proceed now.

Mr. Milbergs, we would like very much to hear from you. You have a prepared statement. We will introduce the entire text of it into the record. You may read the entire [illegible] if you would like, or you may summarize it as you wish. Since you have prepared text, I don't intend to interrupt you as I did Mr. Sallot, and I will reserve my questions until the end. I would also ask for my background and information, could you tell me who you succeeded in office, who was your predecessor, and if you could also give me a little bit about your background in the area of productivity and technology innovation?

TESTIMONY OF EGILS MILBERGS, DIRECTOR, OFFICE OF PRODUCTIVITY, TECHNOLOGY, AND INNOVATION, DEPARTMENT OF COMMERCE

Mr. MILBERGS. Let me begin with myself, first. Before taking my current position as director of the Office of Productivity, Technology, and Innovation, I was working at Stanford Research Institute. I was responsible for science and technology, R. & D. commercialization programs, as well as doing strategic planning work with a variety of corporations in high technology areas. Prior to that, between 1968 and 1972, I worked at OMB. My education is in economics.

As far as my predecessor, there was an Office of Productivity, Technology and Innovation that was under an Assistant Secretary for Productivity, Technology and Innovation, Jordon Baruch.

Mr. LAFALCE. Jordon Baruch was the Assistant Secretary?

Mr. MILBERGS. The Assistant Secretary for Productivity, Technology and Innovation.

Mr. LAFALCE. Who was head of the Office of Productivity?

Mr. DUDLEY. Louis Phillips.

Mr. LAFALCE. No.

Mr. MILBERGS. I don't know who you are referring to.

In any event, what we have done is move the Office of Productivity, Technology and Innovation under the Assistant Secretary for Economic Affairs. We have also proposed to the Congress that this position be upgraded to an Under Secretary for Economic Affairs.

Mr. LAFALCE. Is there an Assistant Secretary for Productivity, Technology and Innovation?

Mr. MILBERGS. We expect to have an announcement come out on that shortly.

Mr. LAFALCE. What will that announcement be?

Mr. MILBERGS. That there will be a candidate, nominated by the President for that position.

Mr. LAFALCE. I see.

Mr. MILBERGS. But the important change that has taken place——

Mr. LAFALCE. I am a little bit confused now. That is why I am asking the question. There is an Assistant Secretary for Productivity, Technology and Innovation, and then there is an office which is——

Mr. MILBERGS. Which is under the Assistant Secretary for Productivity, Technology and Innovation.

Mr. LAFALCE. It seems, not that it overlaps, but it is identical, and that is what confuses me.

Mr. MILBERGS. Well, let me tell you why it is not identical in two kinds of ways. First, O.P.T.I. will be under an Under Secretary for Economic Affairs. Under that Under Secretary, we have the Office of the Chief Economist, the Census Bureau, the Bureau of Economic Analysis, and the Bureau of Industrial Economics, which have the people who collect economic data, as well as analyze economic data. Then, under the Assistant Secretary for Productivity, Technology and Innovation there will be three offices: an Office of Business Analysis, which will be doing competitive assessments on the future of various sectors of the economy; an Office of Strategic Re-

sources, looking specifically into strategic resources, minerals, and materials issues; and my office, the Office of Productivity, Technology and Innovation. The purpose of my testimony is to give you a little background on that.

The important change that we have accomplished here is that technology now becomes an integral part of economic policy. It is the view of the administration that you can't separate economic policy from technology and innovation issues. That is the reason why we have integrated this operation under this proposed Under Secretary for Economic Affairs, that is really the most critical difference.

The other point I might add is that the previous office that Jordon Baruch headed up, had the Patent and Trademark Office (PTO), the National Bureau of Standards (NBS), and the National Technical Information Service (NTIS) reporting to him. PTO and NBS now report directly to the Secretary, upgrading their ability to influence policy in these particular areas, and we are considering various alternatives for the placement of NTIS.

Mr. LAFALCE. Please proceed.

Mr. MILBERGS. Thank you, Mr. Chairman. I am pleased to have the opportunity to express the views of the Department of Commerce on the subject of productivity.

During the past decade, our prosperity became significantly dependent on the global economy. Our total trade—imports plus exports—equaled about 8 percent of the gross national product in 1970; and by 1980, our total trade equaled 18 percent of our GNP.

International competition will become even more intense in the 1980's. Economic growth in the industrialized countries is expected to be somewhat slower during the 1980's. With slower growth in domestic markets, companies around the world will be stepping up their efforts to export. Simultaneously, their foreign competitors will be doing the same.

The competition will be intensified by the entry of the newly industrialized countries as prime suppliers of medium-technology products. This will push the industrial nations of Western Europe and Japan more heavily toward the export of capital goods and high-technology products.

Not only is this going to be a threat to our domestic market shares, it will also challenge our export position directly, since capital goods and high-technology products make up the major components of our industrial exports to the rest of the world.

Our trade policies are designed to move us toward strengthening the U.S. position in the world economy, such as our support for the export trading company legislation. However, our trade performance will depend not solely on increasing access to foreign markets and the trade promotion programs of government. It will also depend on our ability to produce goods that are competitive in price and quality with those produced in other nations.

This brings me to the subject of productivity. The difficulties that we are experiencing in remaining competitive at home and overseas are directly related to a slowing of productivity growth. Expressed simply, productivity is the ratio of output to input. It is a statistical measure of how efficiently we produce goods and services. Usually we measure labor productivity or growth in output

per worker hour. Ideally, we should relate output to a combination of inputs—labor, capital, energy and materials—and analyze the relative importance of each to productivity. The productivity of capital and materials are frequently more important than labor productivity.

At the present time, there are no official Government measures of multifactor productivity, although the BLS has a major program for developing such measures. In addition, productivity measures we use today do not always account for the quality of inputs or outputs, key factors in increasing competitiveness.

Nonetheless, using this limited statistic from 1948 to 1965, real output per worker in the private business sector rose a solid 3.2 percent a year; from 1965 to 1973, it slipped to 2.1 percent a year; from 1973 to 1979, it fell to less than 1 percent year; and productivity actually declined in 1978, 1979, and 1980 and showed only a meager 1.1 percent growth rate in 1981.

The steady drop in productivity rates has not been confined to the United States. All Western nations experienced declines in productivity growth in the 1970's. The United States is still the most productive nation in the world, but it is the steady erosion of the U.S. competitive advantage which is worrisome, rather than the lower productivity in absolute terms. Numerous economists have analyzed productivity data to determine the causes of the long-term downward trend in the growth rate. There is general agreement that a variety of factors are involved, but much less agreement by experts on the precise quantitative role of each.

Mr. LAFALCE. I imagine that you probably read Mr. Denison's paper from the Department of Commerce?

Mr. MILBERGS. Mr. Denison has just recently retired from the Department of Commerce. Certainly he is one of the great experts on this.

Mr. LAFALCE. That paper will prove its complexity.

Mr. MILBERGS. That is right.

Let me mention some of the factors to which Ed Denison attributes this slowdown. One is the capital available to the worker. The capital-labor ratio, as you well know, has been declining. Other factors have been the high rate of inflation, the growth of Government regulation, the lower utilization of capacity, increases in energy costs, changes in the age-sex mix of the work force, a slowdown in civilian research and development, the relative growth of the service sector, the end of the shift from agriculture to manufacturing, and the short-term focus of management behavior. As Ed Denison points out, and after looking at all these factors, almost half of the slowdown is still unexplained—or what he calls the "productivity mystery" or residual.

So we have e ded up studying the problem more than solving it, in my view. We do know by now that there is no single remedy or quick fix for the productivity slowdown. There are many causes. The problem must be addressed on several fronts by both the public and private sectors on a long-term basis.

With respect to the public sector, the Government must achieve a better climate for steady sustainable economic growth. In the past, we have had Government policies which imposed a massive cost on the private sector's ability to invest in long-term productiv-

ity improvement. Government fiscal, monetary, energy and regulatory policies increased both the degree of risk and the risk premium attached to investment decisions. This was especially so for those investments with a long payback period, such as expensive new plant and equipment, research and development, and human resources. Second, longer term savings and investment must be encouraged so that our industrial base can be modernized. The provisions of the President's economic recovery program are designed to encourage such investment, stimulate R. & D., and provide incentives for savings. This will help greatly toward that goal.

Third, we must remove unnecessary barriers to productivity improvement in the private sector. The regulatory relief program is one element that must be continued in order to reduce the burden of Government on business, particularly small business.

To assist in this task, in November 1981, the President established a National Productivity Advisory Committee under the chairmanship of William Simon to explore specific ways of restoring productivity growth in the United States. I would like to point out several important characteristics which differentiate the committee from some of its precedessor organizations. As you probably know, there have been five productivity study commissions, committees or councils in the last 10 years.

First of all, this advisory committee is not intended to produce another voluminous report; it is action oriented. In fact, the Executive order setting it up does not require a report of this committee.

Second, it is linked directly to the policy development process of the Cabinet Council on Economic Affairs. In other words, recommendations will be fed into the decisionmaking forum of the President. It will utilize staff resources of the executive branch rather than employ its own independent staff. In the past, such staffs had a tendency to go their own way and not develop realistic, actionable recommendations.

Mr. LAFALCE. This committee that has been formed by the President with Bill Simon as chairman, it has established four task forces, as I understand it, and I think Roger Porter is the executive director. But he will be relying upon other offices within the executive branch for staff support.

What will the Department of Commerce's role be in providing staff support to that committee?

Mr. MILBERGS. As you mentioned, there are four subcommittees: One on Human Resources, one on Capital Formation, one on the Role of the Government in the Economy, and one on R. & D. and Technological Innovation. The Commerce Department is backing up the Subcommittee on R. & D. and Technological Innovation. Robert Dederick, my boss, is the chairman of the executive branch staff support. We haven't got a good name for it yet.

Mr. LAFALCE. What is your boss' title?

Mr. MILBERGS. Assistant Secretary for Economic Affairs.

Mr. LAFALCE. OK.

Mr. MILBERGS. The chairman for the private sector side is Lewis Branscomb, someone probably well known to you. He is a vice president and the chief scientist at IBM. We are working with the subcommittee currently in anticipation of the next meeting which is scheduled for May 4.

Mr. LAFALCE. That committee only has a 1-year life—perhaps I should have had Roger Porter here testifying on this issue—but do you think it is their intent to come out with some overall plan, policy, and goals? One of the criticisms I voice is that we have not had a clearly enough defined plan to deal with our productivity problems. We have talked about the problems more than we have the solutions necessary to solve the problems, to paraphrase your words. Do you think that at the end of this 1-year period, they will try to develop some comprehensive national plan that could be used for guidance in future years?

Mr. MILBERGS. I can't predict the complete outcome because obviously this is an advisory committee, and one wants to listen to what they come up with. But I will give you a view: My feeling is that over the past few years, the attempt to develop comprehensive solutions has really been a disservice in the sense that they have been so large-scale and complicated. There was no way for the Government to act meaningfully on such comprehensive kinds of solutions.

My own view of the approach we are trying to take in our subcommittee work is to get the winners and actionable items moving and be able to target specific areas with specific recommendations. The notion of a national plan, a comprehensive kind of solution—I don't think that is going to bring us any further to improving productivity. I think our job is to get on with the things that we know about which ought to be changed and get them changed.

Mr. LAFALCE. Well, I couldn't disagree with you more strongly. I think, personally, that is very shortsighted. I agree with you, what you say must be done, but I also think that the individual pieces, doing what we know how to do, and so forth, are not good enough. The individual parts must be part of a larger whole. Otherwise, there will be too many little things that should be done that won't be done. We have to be careful that we can see both the forest and the trees. If we just focus on the trees without seeing the forest, we are not going to solve the problem. If we just focus on the forest and not the trees, we are not going to solve the problem.

Mr. MILBERGS. Let me just respond to that, if I could, Mr. Chairman.

Mr. LAFALCE. Yes.

Mr. MILBERGS. We have started with a comprehensive program. When President Reagan came in and proposed the economic recovery program, we made some very basic decisions about what the strategy and the role of the Government ought to be in economic recovery. It was on the front of tax policy, on the front of spending policy, on the front of monetary policy and regulatory relief policy.

Mr. LAFALCE. I think that we have some fundamental differences too, because for example even assuming that we can agree upon the need for tax incentives to improve productivity, it is this individual's judgment that the tax incentives that American businesses were given were least likely to target the tax incentives to productivity improvement. If we really could have had a group just specifically concerned about productivity, it would have come up with much better types of tax incentives to enhance productivity than 15, 10, 5, 3, and the leasing arrangements, and so forth. I suppose

reasonable men can and do differ, but I haven't heard any reasonable man who would differ with me.

[Laughter.]

Mr. MILBERGS. Mr. Chairman, maybe we could return after I complete my statement.

Mr. LAFALCE. Sure.

Mr. MILBERGS. I would be interested on commenting on the question of targeting later on.

We also believe that it is a proper role for the Government in any program to improve productivity to act as an educator. In other words, help to increase our store of knowledge about the determinants of productivity growth, as well as knowledge about the methods, techniques and processes for improvement.

At this point, I will describe what our Office of Productivity, Technology and Innovation is doing. Our work includes the following activities: The identification and analysis of barriers to productivity improvement and the development of alternative policies to minimize or eliminate their adverse effects. I might point out that one area we are looking into is in the scientist and engineer shortage that was alluded to earlier.

Mr. LAFALCE. Do you have any staff study on that? The National Science Foundation has made some studies along those lines, I believe. What is the status of your looking into it thus far?

Mr. MILBERGS. First of all, we are trying to understand exactly what the nature of the problem is. Is there a real problem? Quite clearly, there has been a lot of press coverage and a lot of attention on what might be called today's problem, the problem with filling certain kinds of positions. But the essential question is: What does the future hold? Is this problem a temporary problem, a cyclical problem, or a fundamental structural problem?

The data do not give a compelling conclusion about where this problem will be over the next decade. We are trying to sort this question out.

The second question we are trying to sort out is what should be the appropriate role of the Federal Government and what is the appropriate role of the private sector. Many solutions to these kinds of problems in the past have neglected the private sector opportunity to provide a remedy. Many public-sector training and education programs that have been set up in the past have tended to operate in isolation of the real private sector needs and didn't effectively involve the private sector in planning things.

So the problem may not really be more public-sector money but more a change in institutional relationships and the incentives between the education establishment and the private sector.

Mr. LAFALCE. I would hope that we could move on that very fast. I think it is important.

Mr. MILBERGS. Another area that we are trying to move forward on is the promotion of increased private sector understanding and use of productivity measurement techniques.

Third, the provision of best practice productivity information to business through our recently established Commerce Productivity Center.

Mr. LAFALCE. I don't know anything about this Commerce Productivity Center. Would you tell me what it is?

Mr. MILBERGS. Yes; I would be happy to. We have had a kind of low-level operation at the Commerce Department over the past 2 or 3 years. It was entitled the "Productivity Reference Center."

Mr. LAFALCE. Productivity Reference Center?

Mr. MILBERGS. Right.

Last year, we responded to about 1,000 requests from business—small business, large business, manufacturing service business—on a whole variety of questions on productivity, all the way from employee incentive programs, productivity measurements, how to introduce robotics, and office automation, to white collar productivity, which is a hot new area of interest.

What we do is provide customized information responses to these people by phone or by letter. This information is then used for starting productivity improvement programs in the private sector.

We look forward to expanding this particular program and will give it a lot more attention and more visibility. What we plan to do is expand the resources of this particular center by plugging into the 30 or so non-Federal productivity centers that exist out there to see if we can build some kind of network to facilitate resource and information sharing.

In addition to that, we are exploring what kind of role we could play in workshops and seminars. As you know, the Commerce Department, at least in the trade and export promotion area, runs many seminars. A key part of achieving competitiveness, I think, is also improving domestic productivity, and we are going to take a look at what role we can play there.

Mr. LAFALCE. How many people do you have at the Office of Productivity, Technology and Innovation?

Mr. MILBERGS. I currently have about 13 people on my core staff, and I have 8 people on detail to me from NBS and NOAA, who have been helping us out.

Those people on detail are helping out in the implementation of the Stevenson-Wydler Act of 1980. It is not correct to say that we are not doing anything in that particular area. The intent of the act we completely agree with, but we are taking a different approach to implementation. Our proposal for next year, for fiscal year 1983, would add——

Mr. LAFALCE. Tell me what the act says—not verbatim, but rather its focus.

Mr. MILBERGS. The Stevenson-Wydler Act provides the Government a role to help stimulate technology, innovation and productivity in the United States.

Mr. LAFALCE. You said it provides a Government role. What does it say the Government shall be?

Mr. MILBERGS. Essentially there are a number of provisions of the act: Section 5, for example, talks about the Government conducting studies on the relationship of technology and innovation to productivity and competitiveness. We are doing some studies and research. We are backing away from doing major comprehensive studies. There was one done 2 or 3 years ago called the "Domestic Policy Review of Industrial Innovation." We are now in the process of trying to act on some of its insights and its recommendations through the National Productivity Advisory Committee, for example.

Section 6 talks about cooperative R. & D. The act calls for the Federal Government to provide seed grants to start cooperative R. & D. programs; and then over a 5-year period, eventually these programs would be completely private-sector financed.

With the R. & D. incentives that have been provided in the Economic Recovery Tax Act, we think there is no need for us to put up-front seed grants. There are adequate incentives for the private sector to put together cooperative programs. Second, we didn't feel the Government was smart enough to figure out which technology areas were going to be the real winners. We think the marketplace is the best judge of which technology areas ought to be supported. We don't think the Government is smart enough to figure out of the dozens and dozens of literally hundreds of different opportunities for cooperative R. & D., which ones really merit the attention. So, what we have done is redirect the program to providing technical assistance, removal of antitrust barriers, and the brokerage of information, as well as Federal laboratory involvement with these private cooperative centers. What I am pleased to report is that the number of cooperative efforts in the private sector are beginning to increase at a rather steady pace.

Mr. LAFALCE. OK. Let us go back to education a bit.

When you look at what the educational problem really is, the extent of the shortage of engineers, scientists and mathematicians, have you gotten to the point where you have gotten together with the Department of Education and its people who are looking at the question? Have you met with people from the National Science Foundation who are looking at that question, with individuals from the private sector such as the Society of Manufacturing Engineers, and others who might be looking at that? Or have you just not reached that point yet?

Mr. MILBERGS. We have met with all those people you have mentioned. We have talked to O.S.T.P., and the National Scienc Foundation. We have had deans of engineering colleges come in, and discuss their view of the problem. I think that is just an essential part of the policy process as you begin to gather information.

We are not at the point of knowing exactly what all the options are. This is the process we will be going through determining where we go from here. So we are more in the data gathering and assessment phase at this stage.

Mr. LAFALCE. All right.

When I asked Mr. Sallot which is the principal office concerned with robotics in the U.S. Government, I assumed it was your office. Would it be your office, or would it be some other office?

Mr. MILBERGS. I would like to just point out that the Federal Government's interest in robotics involves many different organizations. It involves the National Bureau of Standards, which has a robotics activity underway where they are putting together a batch manufacturing operation—a factory of the future, if you will, with no people in it. It will have raw material going in one end and the final product going out the other. This is to serve the Government's own purposes. There is also an industrial research associates program.

Mr. LAFALCE. I saw something pretty close to that at the Yamasaki plant in Japan.

Mr. MILBERGS. Yes. We have a similar program underway, and we are working very closely with industry.

As Mr. Sallot mentioned, the export area is another concern. The Defense Department has a very extensive program underway in manufacturing technology. I don't know if you have a witness coming up in that area, but the Mantech program will be spending over $1 billion over the next 5 years in manufacturing technology: Robotics and CAD/CAM are part of that. Of course, this is a procurement program in order to improve the quality as well as the cost effectiveness of the systems, weapons, and products that they buy.

There are a number of other Federal laboratories involved with various aspects of robotics as well. So, when you say is my office the only focus for robotics; absolutely not.

Mr. LAFALCE. I don't think I said "only." Which office is the principal focus? Is there a coordinating office? Is there a primary office? Is it necessary to have an office which is recognizable by the outside world as the primary, lead office? I always like to have that. It makes me feel comfortable to know that there is the lead office and I can go there, and they can coordinate all my requests with all the other agencies. If I feel more comfortable that way, I would think that American industry might. It might make for better promotion of robotics.

Mr. MILBERGS. My office does not really play a governmentwide coordination role with respect to robotics.

Mr. LAFALCE. Do you think it would be good if some office did?

Mr. MILBERGS. I would have to think about that, because of the difficulties and the frequent failure of various coordination mechanisms that one sees.

Mr. LAFALCE. You aren't against coordination?

Mr. MILBERGS. No. That is not what I am saying. What I am saying is that if you think about robotics as an area of coordination and, let us say, biotechnology as another area of coordination, the material sciences as an area of coordination, the development of new batteries and new energy sources, and so on, one begins to wonder what you are trying to set up when you are trying to coordinate an entire technology area.

We clearly have an interest in robotics. We respond to the private sector who asks questions about robotics. We put them in touch with the people around the Government who know something about robotics.

Mr. LAFALCE. The problem is that when you have all these different offices doing their own individual things, I am afraid the left hand doesn't know what the right is doing. More often than not, the actions of Government become reactive, and only reactive. Good things can happen out of reactions; but it seems to me better things could happen if there is some type of aggressive, coordinative, cohesive attempt to advance the state of the art, implement that state of the art as universally as can be done. I just offer that to you as a suggestion.

Mr. MILBERGS. Mr. Chairman, I appreciate the suggestion. I think there is another kind of consideration involved here which is: How far does one want the Government to move in supporting the development and commercialization of a specific technology area?

The administration is certainly committed to basic research and development.

Mr. LAFALCE. So far.

Mr. MILBERGS. OK. But it is. It is committed to that area.

It is committed to R. & D. for its own purposes, such as in the area of the Department of Defense. It is committed to long term, very high risk kinds of research projects. But when it comes to the actual commercialization and the implementation of some of these new technologies, it is really the marketplace that is most effective. What our role ought to be is to get the barriers out of the way of private initiative in terms of getting this job done. So that is the way we are focusing on it.

Mr. LAFALCE. I guess I am so impressed with the Japanese approach to so many things over the years and at the present time where Government takes a much greater role. It doesn't dominate the private sector, but is much more aggressive than the U.S. Government has been. It seems to me that we are going to need that in the future if we are going to match the great, great strides that the Japanese will be taking in the future.

Mr. SALLOT. May I add something there?

Mr. LAFALCE. Yes.

Mr. SALLOT. I didn't mean to say before that the Stevenson-Wydler Act as such was dead. What I said was that the cooperative technologies program under that act was dead.

There have been some things taking place——

Mr. LAFALCE. In the cooperative technologies program, would you explain what that is purported to be, or should be?

Mr. SALLOT. That is a program that we spent—and I guess this is part of our frustration in the private sector—we spent quite a few years working with the Department of Commerce and the then organizational structure, and then thrust toward productivity, and pointing out those things that needed to be done. We had loads of basic research, but we needed to know how to apply it. We needed to bring small industry, which couldn't afford applications research, into that picture.

So we evolved a cooperative technologies program between academia and industry with some Government support to set up centers to do that. The mechanism, the enabling legislation, and so forth, was in the Stevenson-Wydler Act. We changed administrations, and suddenly all the years of work went down the drain without ever trying. Workshops of industrial private sector people had been held around the country to determine what were the areas of priority of automation, of technologies, and primarily in manufacturing. We came up with 11 major areas in which there ought to be centers of applied research, and were starting to move to do that. Industry had been heavily involved. Government had been heavily involved. Then just like that, it was gone, out the window.

That is what I meant when I said the Stevenson-Wydler Act was not implemented. There was absolutely no continuity. Now we have lost almost 2 years while the department reorganizes, sets up another productivity focus, which we already had. The President has set up a top-level productivity group. We have already gone through five of those. We had some very nice initiatives 2 years ago on what needed to be done on the productivity problem. We

junked that because it didn't come from the right place, I guess, and therefore it wasn't funded.

Now the Department is moving well in the transfer of all its scads of technology that exists in the 700-and-some Government laboratories, which are trying to transfer that technology into the public sector. I don't fault that at all, except that it is underfunded, I think, and underpopulated by staff at the present time.

In the issue of manpower, the American Association of Engineering Societies, which represents 38 groups and covers some 1.2 million engineers and professional people in the United States, has done extended studies on the engineering manpower situation in the United States. It now has the Accreditation Board for Engineers and Technicians under its banner, and this brings in academia. It has all the electrical, mechanical, and other engineers. The AAES prepared testimony and presented it last September or October on the whole problem of training, development, shortages, by geographical areas, shortages by disciplines, and indicated what needed to be done.

The problem at the moment is we don't need any more studies. I would like to amplify what Mr. Milbergs said here. He didn't indicate, I don't think, a piecemeal approach to the problem of productivity. I think what he really said was that the problem was just so awfully big that, if you wait for a total planned approach, you are never going to get anything done. It is so big that the segments are large enough that you can move on a segment at a time. For instance, you can approach the taxation problem. It isn't all that difficult. We had just made a start on that with the safe harbor leasing program, and suddenly that was gone out of the window because somebody said, "I don't like the program; there are too many loopholes in it, and, as of Friday, we aren't going to have it anymore, and I'll see to it." That safely killed the possibility of small companies, which lack capital, to modernize.

Small business, for instance, right now doesn't know what to do. We were just starting to look at the new Government leasing program. Companies didn't have money to afford robots. Robots manufacturers and users could find a company with money who would buy the equipment and lease it back and, "poof," that also, is gone out the window.

I don't mean to fault the efforts of the Department of Commerce at all. I want to make that clear. We have a long history of working with them. But they are—and I would like to make this point—a natural focus because they deal with internal productivity and internal trade. They know what is going on in the Government. They deal with exports. They are aware of the problems and the barriers to export.

So, maybe, while less than perfect—I don't think there is any one perfect point in the Government to coordinate the issue of productivity—it has always seemed to us that the Department of Commerce was that area. Giving it the proper funds and the proper people and a continuity that places it above and beyond the political changes, would permit it to get a job done. We have been struggling with this problem since 1970, to my recollection. I have been involved in it at least since then. Every time you think you got a handle on it, somebody changes it again.

Mr. LAFALCE. Mr. Milbergs, did you care to comment on Mr. Sallot's comments on the cooperative technologies aspect of the Stevenson-Wydler Act?

Mr. MILBERGS. I would just repeat what I said before. The approach that Mr. Sallot had going with the Department of Commerce was an approach that in our view, was highly interventionist. It would involve the Government directly selecting a specific technology for development. It would involve us in some degree of control over the nature of the arrangements that would be made in the private sector, and in terms of how information would be shared.

Finally, we didn't feel it was necessary because, if you look at the evidence, there are plenty of cooperative R. & D. activities going on without Government support. What we are interested in is encouraging private initiative, not Government initiative. It is up to the private sector to select those technology areas and compete in the international arena.

Now, too much credit is given to the Japanese approach in this area. The Japanese success has got a lot more to do with Japanese management as opposed to Japanese Government. Japanese managers tend to take a longer term view, as compared to our American managers. They tend to take a more global view in terms of markets, as opposed to just looking at national markets. They tend to have much greater emphasis on quality, as opposed to the American manager. Finally, they have much better motivated and trained manpower. Those are corporate responsibilities in Japan; those aren't Government responsibilities. They have also a management culture that is willing to learn.

Mr. LAFALCE. I was encouraged to see Secretary Baldrige's comments about 6 months ago that the principal reason for productivity problems in the United States is the shortsightedness of American management.

Mr. MILBERGS. We agree with that completely.

Mr. LAFALCE. Well, I don't know, but he said it.

Mr. SALLOT. We said it, too.

Mr. MILBERGS. Government doing these kinds of things isn't the answer. What we need really to focus on is to create a climate so that the private sector can take that longer term strategic and global kind of view. We have got to put our bets on the businessman, and not on Government. We are facing a tough environment since the Japanese can match our levels of output with 20 percent less manufacturing space, inventories measured in hours as opposed to weeks, and simpler organizational structures. We could learn something maybe.

Our job is to create that climate and get the barriers out of the way and not let the Government mess up private sector decisionmaking.

Mr. LAFALCE. Do you think it is appropriate for the Government to try to educate American management about Japanese management practices?

Mr. MILBERGS. I would hope that the Harvard Business School, the Stanford Business School and other business schools around the country would also take on that kind of role.

Mr. LAFALCE. I think it is appropriate that they also take on that kind of role, absolutely. But it is also appropriate for the U.S. Government to attempt to do something like that, if that is part of the productivity problem, especially if it is a major part?

Mr. MILBERGS. What we are doing with the Commerce Productivity Center is along those lines. We are providing information to business on better ways to get things done. That, I think, is an appropriate role of the Government and, to the degree we have that kind of information, we want to share it. We would like to disseminate it and make it available.

Again, this is not to try to tell business what they must do, but it is to give them the knowledge, information, and options so they can begin to act on it. We have no problem with that kind of role at all. In fact, we are pursuing it.

Mr. LAFALCE. Mr. Milbergs, you have a difficult job, and I appreciate the fact that your task is a great one. I would like to work with you in the future. Any differences we have I am sure are very, very minor. Our goals are definitely the same.

There is one major disappointment I have had with your testimony though, and I haven't addressed it yet, and that is—unless I missed it—I haven't read or heard the word "small." As Chairman of the Small Business Oversight Subcommittee, I am especially concerned about the small business sector. I am concerned that the policies of this administration, and the concerns of this administration do not adequately deal with the problems of the small business sector.

To be sure, you didn't say "big," and you didn't say "small." You could say small is included within the whole context of your remarks. But it seems to me that the small business sector needs special treatment, special concern, maybe special programs. Otherwise, it is just going to miss out. Small businesses are going to miss out on the benefits of our tax legislation, they are going to miss out on the benefits of robotics, et cetera. The SBA, if you will forgive me, is out of the picture. It is not doing very much along these lines. And it seems to me that the Department of Commerce is going to have to be spurred to consider small business more in the future than it has in the past. Have you given any special consideration to small business problems within the jurisdiction of your office? If so, would you expatiate upon that?

Mr. MILBERGS. First of all, I share your concern. Small business is part of the economic landscape and we can't ignore what small business is about. Clearly, in the technology area, we have seen a tremendous explosion, of small businesses. After all, Apple Computer 4 years ago was a rather tiny garage operation; it is now almost a major Fortune 500 company. This is exactly what ought to be going on with the economic recovery program. We want to see entrepreneurship, risktaking increased, and we think the tax program is going to help.

We have got a tough situation right now. We haven't turned the corner on this recession, but we are confident about the basic overall economic program. The best thing we could do for small business is to have a healthy economic climate. That is priority 1 we are pushing.

Specifically, one thing we are doing in my office starting in fiscal year 1983 is implementing Public Law 96-517, which is a law that provides for the first right of refusal of inventions and innovations coming out of Federal R. & D. That law applies to small businesses and nonprofit corporations. My office will be responsible for developing, monitoring, and coordinating the uniform implementation of that law under OBM circular A-124. Right now, we have 26 different approaches to how patents are treated under Federal R. & D. We want to develop a uniform policy.

When the Government retains title to inventions, they are not commercialized. We are not in the manufacturing business. So we want to have small business to be able to commercialize the fruits of the R. & D. they have done under Government contract. So in that specific area, we plan to be pushing forward.

Regarding the technology transfer activities of the 700 laboratories that we talked about earlier, we are working very closely with the Minority Business Development Agency. They have a network of eight commercialization centers around the country. We want to make sure that technological information gets into the hands particularly, of minority business people. We are continuing that program. Clearly, more and more of the small business opportunities of the future, more and more of them, are in the technology areas. We want to make sure that this kind of information gets to them. So those are a couple of examples of the kinds of things we are working on in my office.

Mr. LAFALCE. It doesn't sound like much, not at all. I mean, I know what MBDA does, and that is not much. Do you agree or disagree, Mr. Sallot?

Mr. SALLOT. No; I don't disagree with you at all.

I think that the problem is that it was a new start at the age-old problem. So, I suppose if you look at it in that way, the progress may be great, even though it doesn't contribute much to the whole picture. We've got a mouse when we need an elephant.

Well, I get on that point and I tend to get on a soapbox, and I really shouldn't do it. So I will drop the point.

Mr. LAFALCE. Now is your opportunity to get on the soapbox.

When I heard Joji Arai testify yesterday about what the Japanese Government is doing for the small business community to help them in the field of robotics, for example, to help them with their low-interest loans, the various special programs and the management assistance, with the facilitation of special leasing arrangement, and so forth, it made me think that they are aware of the important contribution of small business and the fact that small business needs special assistance in this area, and that if the United States doesn't do it, small business, which has become an endangered species, will become an extinct species.

Look at our bankruptcies, the tremendous number of bankruptcies that we have in the business community within the past 6 months or so, almost all of whom have been small businesses. The larger businesses can weather the storm.

Mr. SALLOT. Can I soapbox a little bit here?

Mr. LAFALCE. Sure.

Mr. SALLOT. There was an announcement in the paper the other day that General Motors is going to look very heavily at the Japa-

nese KAN/BAN system of inventory. I think we all know what that is, and we all know the differences between its application in Japan and here. GM indicated that what was probably going to happen was that half of their 6,000 suppliers would disappear over the next several years as they looked at this new inventory technique, which I think will be difficult to apply here in the United States.

Now, if you look at the makeup of the satellite suppliers of the automotive industry—and this would be true of Ford also—you find that most of them are small business. Yes, there is a Bendix and some of these other large companies, but by and large, the suppliers are small companies. So you are facing a loss right there, just on the introduction of a new system, of 3,000 small businesses.

I suppose—and I will be blunt about it—the administration's point of view on this particular point would be, "Well, that is the free enterprise system. They have the right to die—or go out of business—just as well as anybody else." I guess I disagree with that philosophy that maybe you have the right to go out of business. I think you also have the right to try to be saved. There is a transition period here—because for 30 years, we have been pursuing one trend of interference and domination by Government—and suddenly on a certain day in January we change courses, and we say, "OK, we are not going to be involved anymore. You are free to do anything you want." That is like tossing your 1-year-old daughter in the pool and saying, "Swim." The odds are she will drown.

You have to recognize that there must be a transition period from the way we have been operating to the way we want to operate. It has been said that, yes, we are going through some dislocations right now, that there are some impediments, there are some inconveniences, and so forth. Some people and companies are going through temporary dislocations, losses and other problems. There is nothing temporary about the man who worked all his life to build a small business and suddenly he is bankrupt because he can't get money to stay alive during the transition, because of high interest rates. That is a permanent thing to that man, there is nothing temporary about it, nor can he recoup his losses.

I think you are on a very sensitive point with me because most of the members of my institute in the manufacturing end are small business people. They need help to get through this period when they are suddenly cast adrift. Big brother government has been running their lives for years and they can't suddenly turn their back and say, "OK, boys, go fend for yourselves. Remember, you have the right to die—or go out of business—just like anybody else." That has been the philosophy, and I think it is a wrong philosophy.

Mr. LAFALCE. All right.

With that, I think we now have to get on to the second panel. I want to thank both Mr. Sallot and Mr. Milbergs for their testimony. I do intend to be in contact with you in the future. I have asked for certain materials. I hope you provide that to me as expeditiously as you can. I do hope to work with you in the future, because this would be a continuing interest of mine and this subcommittee.

I just don't think that the small business sector of our economy has adequately been considered in the whole overall issue of pro-

ductivity, not just robotics, but the whole overall issue of productivity. Somehow, we have got to make people focus on the special needs of small business. I am not really aware of what those special needs are. That is part of my problem. I think we need some better studies on just what their special problems are within the overall problem, much less being aware of the solutions to the problem. That is an area that I hope you will be pursuing, too.

Thank you very much.

Mr. SALLOT. Thank you.

Mr. MILBERGS. Thank you, Mr. Chairman.

[The prepared statement of Mr. Milbergs follows:]

PREPARED STATEMENT OF EGILS MILBERGS, DIRECTOR, OFFICE OF PRODUCTIVITY, TECHNOLOGY, AND INNOVATION, DEPARTMENT OF COMMERCE

I am pleased to have this opportunity to express the views of the Department of Commerce on the subject of productivity and to review with you some of our ideas on ways to bring about improvement. The level and rate of growth of productivity is central to stimulating economic recovery, increasing our standard of living, and promoting the international competitiveness of American industry.

During the past decade, our prosperity became significantly dependent upon the global economy. At the beginning of the past decade, our total trade—imports plus exports—equaled about 8 percent of the gross national product; by 1980, our total trade equaled 18 percent of our GNP.

International competition will become even more intense in the 1980's. Economic growth in the industrialized countries is expected to be somewhat slower during the 1980's. With slower growth in domestic markets companies around the world are already stepping up their efforts to export. Simultaneously, their foreign competitors will be doing the same.

While the industrialized countries will be scrambling for new markets, the competition will be intensified by the entry of newly industrialized countries as prime suppliers of medium-technology products. These countries will compete with our industries in our own markets, and in the other developed countries.

The growth in developing country exports of medium-technology products is pushing the industrial nations of Western Europe and Japan more heavily toward the export of capital goods and high-technology products. In the manufacturing sector, this trend is challenging our export position directly, since capital goods and high-technology products make up the major components of our industrial exports to the rest of the world.

Our trade policies are designed to move us toward strengthening the U.S. position in the world economy and both business and government are working hard to reduce the trade deficit. However, our trade performance will depend not solely on increasing access to foreign markets and the trade promotion programs of government to sell U.S. products abroad. It will depend also on our ability to produce goods that are competitive in price and quality with those produced in other nations.

This brings us to the subject of productivity. The difficulties that we are experiencing in remaining competitive at home and overseas are directly related to a slowing of productivity growth and rising unit labor costs.

Expressed simply, productivity is the ratio of output to input, and it is our best statistical measure of how efficiently we use labor, capital, and other resources to produce goods and services.

Usually, we speak in terms of labor productivity or growth in output per worker-hour. Ideally, we should relate output to a combination of inputs—labor, capital, energy and materials, and analyze the relative importance of each to productivity.

At the present time, there are no official government measures of multifactor productivity, although the Bureau of Labor Statistics has a major program for developing such measures for the U.S. economy. In addition, productivity measures do not always account for the quality of inputs or outputs, key factors in increasing competitiveness.

From 1948 to 1965, real output per worker in the private business sector—the typical, but not necessarily the best statistical series—rose by a solid 3.2 percent a year; from 1965 to 1973, the rate of productivity growth slipped to 2.1 percent a year; and from 1973 to 1979, it fell to only 0.8 percent a year. Productivity actually declined in 1978, 1979, and 1980, and showed only a meager 1.1 percent growth rate in 1981.

The steady drop in productivity growth rates has not been confined to the United States. With regard to the manufacturing sector, all Western industrial nations experienced declines in productivity growth during the 1970's, but the percentage drop in the U.S. rate exceeded that of every other country except the United Kingdom and Sweden.

During the fourth quarter of 1981, as a result of the recession output per hour in the non-farm private economy declined at a rate of 6.8 percent and unit labor costs rose at the rate of 14.0 percent. Disturbing as those quarterly figures are, they do not indicate a trend. We are more concerned about the underlying long-term productivity performance.

The United States is still the most productive Nation in the world, but it is the steady erosion of the U.S. competitive advantage which is worrisome, rather than lower productivity in absolute terms.

Numerous economists have analyzed productivity data to determine the causes of the long-term downward trend in the growth rate. There is general agreement that a variety of factors are involved, but much less agreement on the precise quantitative role of each.

While the decline in the capital available to the worker is certainly a very important determinant of productivity growth, it is not the only one. Other factors include: the high rate of inflation; the growth of government regulation; low utilization of capacity; increases in energy costs; changes in the age-sex mix of the workforce; a slowdown in civilian research and development; the relative growth of the service sector; the end of the shift from agriculture to manufacturing; and the short-term focus of management attitudes and behavior.

So far, we have studied the problem more than solved it. We do know by now that there is no single remedy or quick-fix for the productivity slowdown. Instead, the problem must be addressed on several fronts by both the public and private sectors.

First, the government must achieve a better climate for steady, healthy, and—above all—sustainable economic growth. In the past, we have had government policies which have imposed a massive cost on the private sector's ability to invest in long-term productivity improvement. Government fiscal, monetary, energy, and regulatory policies increased both the degree of risk and the risk premium attached to investment decisions. This was especially so for those investments with a long payback period such as expensive new plant and equipment, research and development, and human resources.

Second, longer-term savings and investment must be encouraged so that our industrial base can be modernized. The provisions of the President's Economic Recovery Tax Act are designed to encourage investment, stimulate R&D, and provide incentives for savings, will help greatly toward this goal.

Third, we must remove unnecessary barriers to productivity. Part of this task involves the review of laws, regulations, and paperwork requirements to determine whether they have outlived their original purposes. The regulatory relief program is one element that must be continued in order to reduce the burden of government on business, particularly small business.

To assist in this task, in November 1981, the President established a National Productivity Advisory Committee (NPAC) to explore specific ways of restoring productivity growth in the United States. The NPAC is specifically charged with the responsibility to "advise the President and the Cabinet Council on Economic Affairs on the Federal government's role in achieving higher levels of national productivity and economic growth." It will not be possible for the Committee to examine every Federal government activity that may impede productivity; for that reason, its mandate concentrates the Committee's efforts on those areas where the government's capacity for change and improvement is greatest.

There are several important characteristics which differentiate the Committee from some of its predecessor organizations: It is not intended to produce another voluminous report; it is linked directly to the policy development process of the Cabinet Council on Economic Affairs; and it will utilize staff resources of the Executive Branch, rather than employ its own independent staff. The Committee has a finite life of one year in which to complete its work and submit its recommendations.

Fourth, we believe that a proper role for government in any program to improve productivity is that of educator—in other words, helping to increase the store of knowledge about the determinants of productivity growth, as well as knowledge about methods, techniques, and processes for improvement.

At this point, I would like to describe briefly what we at the Department of Commerce are doing to enhance productivity growth. The newly reconstituted Office of Productivity, Technology and Innovation (OPTI) will be under the proposed Under Secretary for Economic Affairs. OPTI's activities include:

Identification and analysis of barriers to productivity improvement and the development of alternative policies to minimize or eliminate their adverse effects;

Promotion of increased private sector understanding and use of productivity measurement techniques, especially through a voluntary, pilot, interfirm productivity measurement project;

Provision of best practice productivity know-how to business through our recently established Commerce Productivity Center, which maintains a unified system for the collection, analysis and dissemination of productivity information and which will provide special assistance through workshops and seminars;

Operation of a new internal coordination mechanism, with OPTI as the focal point, to ensure a cohesive approach in all DOC productivity programs, policies, legislative initiatives, and administrative changes; and

Development of new methods for transferring Federally funded technologies to business and facilitating private sector efforts in cooperative technologies. These activities reflect OPTI's implementation of the intent of the Stevenson-Wydler Technology Innovation Act of 1980, without relying on Federal grants and subsidies.

In fiscal year 1983, we plan to begin work on two new projects—coordination of Federal patent policy and activities to support voluntary conversion to the metric system.

Specific projects currently in progress include a study to develop measures of productivity for some 90 individual industries using the so-called total factor concept. When this study is completed by the Bureau of Industrial Economics, we will be able to measure and analyze the contribution of each factor of input to the output of those industries. Another research project is examining the effects of the shortage of scientific and engineering personnel needed by industry with a view toward developing a private-sector remedy to this problem.

Our productivity information services are beginning to achieve results. Last year the Commerce Department responded to over 1,000 requests from companies seeking information on methods and techniques to improve productivity. We have provided customized information on such topics as employee incentive programs, quality control circles, labor-management committees, office automation, new process technologies such as robotics and computer-aided manufacturing and productivity measurement. Requests come from manufacturing and service firms, universities, consulting firms, and even Federal, state and local governments. We have dealt with everyone from first line supervisors to CEO's.

We are pleased to report that this information has stimulated new productivity initiatives within the private sector.

I would like to conclude by stressing a final point of particular importance to the outlook for U.S. productivity growth. That is the pivotal role to be played by American management.

All too often top U.S. managers have adopted strategies tied to short range, cyclical concerns rather than to needed longer-term planning. Marketing approaches have stressed quick returns rather than the development of future markets. Management energies have been absorbed with sustaining stock prices to defend against acquisition, rather than focusing on production, quality improvements, and productivity. Management of the next decade is the management of change. No product or process will likely have more than a 5–10 year life. That is, a piece of equipment will be obsolete before its useful life can be realized. The role of management is one of continuous technology updating, human resource development and strategic planning.

Moreover, to compete in the world of the 1980's management must assume a more global perspective. The days of isolated national markets are over for most industries. This means that trade should become an integral part of corporate planning for many firms. There are some 20,000 firms which could be exporting, but are not.

In addition, management and labor must look at their relationship in a new context. The adversarial relationships of the past could be tolerated then because they were concerned how to distribute an ever-expanding output of goods and services. We can no longer take such growth for granted. Management should develop a new awareness of—and respect for—the underutilized capacities of the American worker. Labor should be treated not as a "cost," but as a resource. Similarly, employees must develop a new sense of responsibility for the total production process, the quality of the final product, and negotiate wage agreements which reflect the new competitive realities.

The Administration has worked to improve relations between U.S. government and business, and has achieved substantial progress in deregulating major sectors of the economy. In spite of this, productivity growth will require more than government getting its own house in order, and more than exhortation by government offi-

cials and business leaders. The greatest opportunity for productivity improvement rests with the private sector and the climate is now favorable for business to take the necessary initiative.

Mr. LAFALCE. I now call panel No. 2, Dr. David Clifton and Sherman Dudley, and Mr. Mitchell Fein.

Dr. Clifton and Mr. Dudley.

PANEL CONSISTING OF DR. DAVID CLIFTON, JR., SHERMAN DUDLEY, AND MITCHELL FEIN

TESTIMONY OF DR. DAVID CLIFTON, JR., AND SHERMAN DUDLEY, GEORGIA PRODUCTIVITY CENTER, GEORGIA INSTITUTE OF TECHNOLOGY, ATLANTA, GA.

Dr. CLIFTON. Mr. Chairman, we are pleased to respond to your request for an account of our experience at the Georgia Productivity Center transferring technology primarily to small- and medium-sized businesses. We plan to inform you of the mechanisms we use to transfer technology, some of the difficulties we have encountered, and some of the successes we have enjoyed. I have prepared a handout, which you have. I am not going to read it verbatim, but I will cover some of the points that it discusses. It basically relates the background of the Georgia Productivity Center and discusses the center's experience and the useful lessons we have learned from that experience.

We also have a brief slide presentation focusing on some of the firms we have worked with in the last few years, and we will show that. When the slide presentation ends, Mr. Sherman Dudley, one of our field engineers in the south Georgia area, will join me in responding to whatever comments or questions you might have.

The Georgia Productivity Center was established in 1975. It is the Nation's first State center dedicated to improvements in business and industrial productivity. Its home base is the Georgia Institute of Technology, one of the Nation's leading engineering institutions. Among the more than 200 universities in the United States offering engineering degrees, Georgia Tech ranks among the top 5 in level of research activity. Building on these capabilities, the Georgia Productivity Center offers problem-solving services in four areas: Innovation, research and development, safety and environmental counseling, and human resources.

The center's success can be attributed to the good relations it has maintained with Georgia industry. Last year, we worked with nearly 2,000 firms in the State. We assisted them with material handling techniques, plant layouts, introduction of microcomputers, process improvement, occupational safety and health, and a number of other activities.

The model of technology transfer we use at the Georgia Productivity Center is really a key to the success of our efforts to date. The staff consists mainly of engineers with management backgrounds and industrial experience. They are based throughout the entire State—we have eight area offices—and they get to know their territory very well. These field engineers work with the companies in their territories on a day-to-day basis. They identify problems, needs, and areas for potential improvement for these firms. If these engineers cannot provide the technical assistance themselves,

they call on our support staff on the Georgia Tech campus in Atlanta, who take the problems referred to them by the field engineers, comb the technical literature, and confer with experts at Georgia Tech or elsewhere to generate solutions or possible solutions to be referred back to the field engineer.

The key point here is that the field engineer takes the solution to the company, works with the company on a 1-to-1 basis to implement the improvement, and then returns on a regular basis to see if the implementation is going well, if it has encountered any problems, and so on.

This has been very successful for us, and I would like to mention two particular examples. Over the last 15 years, we have worked with the Rainbow Manufacturing Co., a manufacturer of irrigation systems in Fitzgerald, Ga.

Initially, we helped the company when it had problems with its aluminum foundry. Later we helped it with a technical problem of excess vibration, causing bearing failure in a centrifugal pump. Currently, we are working with the company to design an electronic control system to help with the movement of irrigation equipment. When we first started with Rainbow, its annual sales were approximately $1 million. At present, Rainbow employs 135 people and enjoys sales of more than $15 million.

Another example of the work we have done is the preventive maintenance management system we designed and implemented for a county government in north Georgia. Repair costs for expensive road maintenance equipment were mushrooming. We analyzed the problem and discovered that it had essentially two components: one was worker motivation, setting up a system to motivate workers to perform maintenance tasks; the other was that the workers needed more specific preventive maintenance training. We designed and implemented both training and motivational systems. It is estimated that in this next year, this county will save 20 percent of its $300,000 maintenance and repair budget, with more savings to come in the future.

An important point about this project is that once it is implemented, we can take the system, document it, and forward copies to the other field engineers who can transfer the system and its benefits to other counties within the State.

We work primarily with small- and medium-size firms. Our assistance is cost free. We find that many of these firms we work with desire to innovate, but just cannot afford technical assistance at the level they need. They are afraid of failure, and justifiably so. One failure at an attempt at innovation could mean the difference between a very viable firm and one that goes under. They also need financing to help implement some of the recommendations we bring to them.

One of the questions we were asked to address is: Can the success of the Georgia Productivity Center be replicated in other States? The Georgia Productivity Center's success rests on three essential components which are linked very closely together: The first is access to the support provided by, a broad base of state-of-the-art technical expertise at Georgia Tech. The second is field engineers with strong industrial experience who work directly with firms on productivity improvement. And the third is a technical staff that

serves as an intermediary between the technical information and expertise on the Georgia Tech campus and the field engineers seeking to solve specific problems they encounter in the firms they work with.

I think any State with a strong technical research base, such as a research college, can implement a system similar to this one. Our experience, however, has shown that unless you have all three components, the program will not be very successful. There really is no way to cut corners. The 1-to-1 interaction between a company and a technical specialist backed by the extensive resources of a large research institution is the only model the Georgia Productivity Center has identified capable of generating true and lasting productivity savings. The problem is neither quick, easy or inexpensive, but it does produce results.

The Arthur D. Little Co. identified a benefit-to-cost ratio of 22 to 1 for the Georgia Productivity Center. There is no reason, given the presence of the three components I just mentioned, that this program couldn't serve as a successful model and be implemented elsewhere.

That concludes my preliminary comments.

Mr. DUDLEY. We would like to show you this slide presentation which will give you a clearer understanding of specific cases the Georgia Productivity Center has worked on.

Dr. CLIFTON. I also think it conveys a clear sense of what exactly we mean when we talk about small- and medium-sized companies, and their level of sophistication and technology at which they operate.

[A slide presentation.]

[The verbatim transcript of slide presentation follows:]

INDUSTRIAL EXTENSION SERVICE

1. SLIDE:

HERE'S WHAT GEORGIANS ARE SAYING ABOUT GEORGIA TECH'S INDUSTRIAL EXTENSION SERVICE:

2. SLIDE:

SUPER BILLY HAYNES
HAYNES INDUSTRIES
WAYCROSS

BILLY HAYNES OF HAYNES INDUSTRIES IN WAYCROSS SAYS HE MIGHT NOT HAVE SURVIVED WITHOUT THE HELP OF TECH. (AUDIO TAPE) "IT MORE THAN LIKELY HELPED KEEP OUR DOORS OPEN."

3. SLIDE:

SUPER JIM FRANK SMITH
COMMISSIONER
HARALSON CO.

JIM FRANK SMITH, COUNTY COMMISSIONER OF HARALSON COUNTY: (AUDIO TAPE) "IT'S GOING TO SAVE ME CLOSE - BETWEEN $70,000 - $100,000."

4. SLIDE:

SUPER JOHN FOSTER
HABERSHAM BROOM
CORNELIA

JOHN FOSTER OF HABERSHAM BROOM CO. IN CORNELIA: (AUDIO TAPE) "I VIEW IT LIKE A COUNTY AGENT WORKING WITH THE FARMERS. I THINK IT'S A GREAT PROGRAM!"

5. SLIDE:

SUPER BOLLING JONES
GA. CRATE & BASKET
THOMASVILLE

BOLLING JONES OF GEORGIA CRATE AND BASKET CO. IN THOMASVILLE: (AUDIO TAPE) "A COMPANY OF OUR SIZE IS NOT USUALLY BIG ENOUGH TO HAVE ITS OWN INDUSTRIAL ENGINEER AND WE DON'T HAVE ANY TRAINED PEOPLE IN THAT LINE AND ED WAS ABLE TO SHOW US THAT HE COULD WORK WITH US ON A CONSULTING BASIS AND THIS WOULD HELP US TO ACCOMPLISH AN EFFICIENCY PROGRAM IN OUR ORGANIZATION."

6. SLIDE:

SUPER JOE JENKINS
CABLE ANALYSIS
LEARY, GA.

JOE JENKINS OF CABLE ANALYSIS IN LEARY, GEORGIA: (AUDIO TAPE) "WE WENT TO THE SMALL BUSINESS ASSOCIATION AND TO SCORE. THEY UNDERSTOOD OUR PLIGHT BUT THEY COULD NOT UNDERSTAND

		THE TECHNICAL CONCEPTS. GENE TOLD US ABOUT GEORGIA TECH. HE HAS A FRIEND WHO WORKS IN THE ENGINEERING DEPARTMENT OF TECH. HE COULD IDENTIFY WITH THE TECHNICAL AND WITH THE MANAGEMENT ASSISTANCE THAT WE NEEDED AND IN TURN PUTTING BOTH OF THESE TOGETHER, HE GAVE US THE ASSISTANCE THAT WE NEEDED."
7.	SLIDE: TECH TOWER	THE EXPERT SERVICES OF GEORGIA TECH ENGINEERS REACH FAR BEYOND THE CAMPUS IN ATLANTA - THANKS TO THE GEORGIA GENERAL ASSEMBLY.
8.	SLIDE: STATE CAPITOL	THE LEGISLATORS, UNDERSTANDING THAT SMALL BUSINESSES AND INDUSTRIES OFTEN CAN'T AFFORD ENGINEERS OR CONSULTANTS, PROVIDED FUNDS FOR THE BEGINNING OF THE INDUSTRIAL EXTENSION SERVICE.
9.	SLIDE: GEORGIA PRODUCTIVITY CENTER	IN 1975, THE LEGISLATORS DESIGNATED TECH AS THE STATE'S OFFICIAL PRODUCTIVITY CENTER...AND THE INDUSTRIAL EXTENSION SERVICE BECAME A PART OF THAT CENTER.
10.	SLIDE: FIELD OFFICES	NOW, ENGINEERS ARE PERMANENTLY STATIONED AT 8 FIELD OFFICES ACROSS THE STATE, PROVIDING ASSISTANCE AND INFORMATION EACH YEAR TO MORE THAN 2,000 NEW AND ESTABLISHED INDUSTRIES AS WELL AS COUNTY AND LOCAL GOVERNMENTS.
11.	SLIDE: ASSISTANCE	MOST ASSISTANCE PROJECTS ARE SHORT TERM AND ARE PROVIDED AT NO COST TO THE COMPANIES. MORE EXTENDED WORK CAN BE DONE UNDER CONTRACT.
12.	SLIDE: HAYNES IND.	IN WAYCROSS, BILLY HAYNES QUIT THE RAILROAD AND BEGAN HIS OWN BUSINESS REPAIRING RAILROAD CARS. FOR NINE

		MONTHS. HE DIDN'T EVEN DRAW A SALARY. HE SAID TECH ADVICE MORE THAN LIKELY HELPED KEEP HIS DOORS OPEN AND NOW TECH HAS HELPED WITH PLANS TO DOUBLE THE SIZE OF HIS PLANT, GOING FROM 40 EMPLOYEES TO 80.
13.	SLIDE: EQUIPMENT	MANY SMALL CITIES AND COUNTIES ARE STRUGGLING WITH INCREASED COSTS OF ROAD MAINTENANCE EQUIPMENT.
14.	SLIDE: HARALSON COUNTY	SO TECH'S OFFICE IN ROME IS WORKING WITH HARALSON COUNTY TO DESIGN A MODEL PROGRAM OF PREVENTIVE MAINTENANCE THAT CAN BE COPIED BY OTHER COUNTIES.
15.	SLIDE: HABERSHAM BROOM	IN CORNELIA, THE HABERSHAM BROOM COMPANY HAD BEEN MAKING BROOMS THE SAME WAY FOR 50 YEARS AND WAS BARELY BREAKING EVEN.
16.	SLIDE: HABERSHAM BROOM	THE GAINESVILLE OFFICE OF TECH CAME UP WITH A NEW PLANT LAYOUT, A BETTER PRICING SYSTEM AND IMPROVED PRODUCTION SCHEDULING - ALL OF WHICH WILL DOUBLE THE SALES VOLUME.
17.	SLIDE: GA. CRATE & BASKET	IN THOMASVILLE, THE GEORGIA CRATE AND BASKET COMPANY NEEDED HELP TO SURVIVE THE RECESSION AGAINST TOUGH COMPETITION.
18.	SLIDE: GA. CRATE & BASKET	TECH'S ALBANY OFFICE CAME TO THE RESCUE. WAREHOUSE ARRANGEMENT AND PURCHASING HAS BEEN REORGANIZED. A NEW MANAGEMENT CONTROL SYSTEM IS BEING INSTALLED. AND A NOISE CONTROL PROGRAM MEETS OSHA STANDARDS.
19.	SLIDE: CABLE ANALYSIS	WHEN CABLE ANALYSIS IN LEARY, GEORGIA, CONTACTED THE ALBANY OFFICE, THE COMPANY

	WAS NEAR COLLAPSE. BUT THEIR TECHNICAL SKILLS WERE FIRST RATE - SO TECH HELPED THEM WITH A MARKETING PROGRAM TO
20. SLIDE: CABLE ANALYSIS	REACH THEIR CUSTOMERS - SMALL, INDEPENDENT TELEPHONE COMPANIES WHO NEED PREVENTIVE MAINTENANCE AND REPAIR OF UNDERGROUND CABLE.
21. SLIDE: WAYCROSS	IN HAZELHURST, ENGINEERING ADVICE FROM THE DOUGLAS OFFICE HELPED A SMALL CONCRETE COMPANY CUT ITS LABOR TURNOVER AND INCREASE PRODUCTIVITY MORE THAN 30 PERCENT.
22. SLIDE: OSHA	PRODUCTIVITY SUFFERS WHEN TIME IS LOST TO JOB ACCIDENTS AND SICKNESS. GEORGIA TECH OFFERS FREE AND CONFIDENTIAL CONSULTATION SERVICES TO EMPLOYERS WHO WANT TO ELIMINATE HEALTH AND SAFETY HAZARDS.
23. SLIDE: OSHA	FOR EXAMPLE, TECH ENGINEERS HELPED A SMALL SPINNING COMPANY TO ELIMINATE A PROBLEM WITH CHEMICAL EXPOSURE TO A SYNTHETIC FIBER WHICH WAS FORCING EMPLOYEES TO TAKE SICK LEAVE.
24. SLIDE: SUPER JOBS	THE PAYOFF FOR THE INDUSTRIAL EXTENSION SERVICE IS JOBS...CREATING NEW ONES, PRESERVING EXISTING ONES, AND MAKING THEM ALL MORE PRODUCTIVE.
25. SLIDE: SMALL COMPANIES 98% OF BUSINESSES 65% OF EXISTING JOBS 69% OF NEW JOBS	THIS COMBINED EFFORT OF THE GEORGIA GENERAL ASSEMBLY AND GEORGIA TECH IS AIMED PRIMARILY AT SMALL COMPANIES - BECAUSE THEY REPRESENT 98 PERCENT OF THE BUSINESSES IN GEORGIA - EMPLOYING 65% OF ALL WORKERS - AND CREATING 69% OF THE NEW JOBS!

26.	SLIDE: MANUFACTURING VS OTHERS	AND IT MAY COME AS A SURPRISE TO SOME THAT MANUFACTURING IN GEORGIA ACCOUNTS FOR MORE JOBS THAN AGRICULTURE, MINING, CONSTRUCTION, UTILITIES, TRANSPORTATION, FINANCE, INSURANCE AND REAL ESTATE COMBINED!
27.	SLIDE: BENEFIT/COST	AND HOW EFFECTIVELY IS TECH SERVING THIS KEY GROUP? THE RESPECTED FIRM OF ARTHUR D. LITTLE STUDIED THE PROGRAMS AND ESTIMATED A BENEFIT TO COST RATIO OF 22 TO 1. IN OTHER WORDS, FOR EVERY $1 INVESTED, THE PROGRAM GENERATED BENEFITS OF $22.
28.	SLIDE: INDUSTRIAL EXTENSION SERVICE	THAT'S THE SUCCESS STORY OF GEORGIA TECH'S INDUSTRIAL EXTENSION SERVICE.
29.	SLIDE: BLANK	

Dr. CLIFTON. That slide show conveys a little bit of a broad orientation of the Georgia Productivity Center. The extension service is part of the Georgia Productivity Center.

Mr. LAFALCE. The extension service is part of the Productivity Center?

Dr. CLIFTON. Right.

Mr. DUDLEY. This extension service was created in 1961. In fact, I have worked 12 years in the field at a remote office away from Atlanta.

One fact I have observed concerning small manufacturers is that the manager wears all the hats within the organization there. The general manager normally handles the finances of the company, and serves as the technical staff, purchasing agent, and production supervisor. In most cases, these people lack the resources necessary to make technical decisions and incorporate new, more efficient technology into their operations.

I have also observed productivity gains do not necessarily involve or require sophisticated technology. Equipment currently on the shelf would significantly increase the productivity of Georgia industry. I don't know that I could generalize on the national level. We have a great deal of equipment capability that hasn't been applied. For that reason, we are successful in what we do.

Mr. LAFALCE. You might even be discarded by some of the larger businesses, and yet be extremely beneficial to the small businesses.

Mr. DUDLEY. That is right.

Mr. LAFALCE. It might be an advance for the smaller, even though it is obsolete for the larger.

Mr. DUDLEY. You are exactly right. Used equipment is a ready source that we routinely look into the equipment area.

What I think sets our center apart from other programs in the United States from most people in with similar goals is our network of statewide offices.

This network does not only allow us to provide information to companies, but enables us to follow up with implementation assistance.

Mr. LAFALCE. Did you say you have eight offices?

Mr. DUDLEY. Eight offices and thirteen staff throughout the State.

Mr. LAFALCE. How large is the Georgia Productivity Center? How many people do you have?

Dr. CLIFTON. The umbrella organization takes in about 50 people. We have 13 professionals in the extension section, 10 professionals in the safety and health section, and 7 professionals in the energy extension section.

Mr. DUDLEY. The 13 professionals in the extension section are located out in the State.

Mr. LAFALCE. I didn't hear you. The umbrella organization embraces about 50 people. I didn't hear what you said after that.

Dr. CLIFTON. We have approximately 13 people out in the extension section of this organization, with funding and finance provided by the State.

Mr. LAFALCE. What is that, the 13 to 15?

Dr. CLIFTON. Right.

Mr. LAFALCE. State funded?

Dr. CLIFTON. Right.

The rest of the assistance we provide would be generated by, for example, the occupational safety and health consultation program.

Mr. DUDLEY. That is a Federal program. The moneys come directly to the State of Georgia.

Mr. LAFALCE. The State of Georgia allocates that money to the Georgia Productivity Center?

Mr. DUDLEY. Right. There are nine engineers in that office that work to provide safety and health consultation service to Georgia manufacturers on a confidential basis. This group not only identifies violations, but helps firms develop solutions to their safety and health problems. It is Federal money that comes into this program.

Mr. LAFALCE. You have roughly 50 people. So what is your total overall budget?

Dr. CLIFTON. Probably around $1 million, for salaries and wages.

Mr. LAFALCE. $1 million for 50 people?

Dr. CLIFTON. They are not fully committed people.

Mr. DUDLEY. Right. I can call on a specialist.

Mr. LAFALCE. They are not 50 full timers then?

Dr. CLIFTON. No.

Mr. LAFALCE. How many full timers do you have?

Mr. DUDLEY. Thirty.

But if I have a question on, for example, incentive compensation or training, I can call on a specialist to provide me a resource that wouldn't otherwise be available.

Mr. LAFALCE. You mean you are able to have a statewide productivity center for $1 million?

Mr. DUDLEY. Statewide to the degree that I, in my area of 25 counties, have about 500 firms to work with. So my impact is greatly diminished because I have that many firms. In a given year, I may deal with 200 to 250 companies to varying degrees, from responding to an information request to providing 5 days of free con-

sultation. Monday of this week I worked with a company that is implementing an electrostatic spray paint system that is going to increase their paint efficiency significantly. That only required 1 day's time.

Mr. LAFALCE. Doesn't the State of Georgia also have what is known as either a UBDC or an SBDC?

Mr. DUDLEY. Right.

Mr. LAFALCE. Is it the former, a UBDC?

Mr. DUDLEY. No; it is an SBDC.

Mr. LAFALCE. The SBDC is the Small Business Development Center?

Dr. CLIFTON. Right.

Mr. LAFALCE. Now, what is the SBDC in Georgia, as opposed to the Georgia Productivity Center?

Mr. DUDLEY. The SBDC operates out of a sister institution in the University of Georgia system. It is the business school, with a liberal arts program. Georgia Tech is almost exclusively an engineering institution. The SBDC operates through junior colleges, primarily for educational purposes.

Mr. LAFALCE. The SBDC would primarily be management assistance?

Mr. DUDLEY. Management assistance primarily in the area of retail and service. Our interest is primarily in manufacturing. We very seldom deal with retail clients. In fact, we send SBDC referrals in the areas of retail and service.

A company representative in the slide presentation said he had gone to the Small Business Association; he had actually gone to the SBDC in Albany, Ga.

The SBDC didn't understand the technical problems associated with his business. SBDC uses faculty members; we use a full-time engineering staff. They also use some students.

Mr. LAFALCE. You don't use faculty at Georgia Tech?

Mr. DUDLEY. Not very often. We primarily use full-time engineers.

Mr. LAFALCE. When you say full-time engineers, is that on your own staff?

Mr. DUDLEY. On our own staff.

Mr. LAFALCE. OK.

Mr. DUDLEY. Sometimes, on occasion, I will have a question for which I need to seek in-depth assistance.

Mr. LAFALCE. You must pay them pretty well if they are this qualified. Yet, $1 million doesn't go that far. What do you pay this full-time engineer?

Mr. DUDLEY. Our average salary is approximately $33,000.

Mr. LAFALCE. Are there other States that have similar programs, to your knowledge?

Mr. DUDLEY. Pennsylvania.

Dr. CLIFTON. North Carolina, too.

Mr. DUDLEY. North Carolina has a similar organization working in the furniture industry.

Mr. LAFALCE. Just the furniture industry?

Mr. DUDLEY. Primarily; that is their primary focus.

Mr. LAFALCE. That is a pretty big industry in North Carolina.

Mr. DUDLEY. That is right. The program is run throughout North Carolina State University.

Mr. LAFALCE. Yes.

Mr. DUDLEY. Then there is PENNTAP, the Pennsylvania technical assistance program. The director there is Leroy Marlow.

Mr. LAFALCE. They are the only other States that you know of?

Mr. DUDLEY. They are the major ones, to my knowledge, with long-standing programs.

Mr. LAFALCE. Do we have anything in the Federal Government that you think is analogous at all?

Mr. DUDLEY. Not really. Our system was patterned after the Cooperative Extension Service used in agriculture.

Mr. LAFALCE. That is what the representative from the Japan Productivity Center was talking about yesterday.

Mr. DUDLEY. This approach was proposed under Stevenson-Wydler.

Mr. LAFALCE. Yes. Speaking of the Stevenson-Wydler after 1980, and the comments that were made both by Mr. Sallot and Mr. Milbergs, did you people have any comments on that?

Mr. DUDLEY. It establishes a framework for a national network similar to our Productivity Center in Georgia.

Mr. LAFALCE. It just hasn't been implemented?

Mr. DUDLEY. It just hasn't been implemented.

Mr. LAFALCE. OK.

Mr. DUDLEY. It establishes the framework. Nothing has been implemented.

Mr. LAFALCE. Could you provide me with a copy of the report or a summary of the report of the Arthur D. Little Co. which said there is a 22 to 1 cost-benefit ratio?

Mr. DUDLEY. Certainly.

[The information referred to above follows:]

PROGRAM EVALUATION OF THE

OFFICE OF STATE TECHNICAL SERVICES

prepared for

DEPARTMENT OF COMMERCE

Office of Program Planning

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I. INTRODUCTION

A. BACKGROUND

1. The State Technical Services Program

The State Technical Services (STS) Program was created by Act of Congress in 1965* "to [illegible] growth of the States and the country through an improved application of technical and scientific knowledge." The program was designed to achieve three objectives:

> "(1) Strengthening the nation's economy by upgrading industries through the utilization of advanced technology, thereby thoroughly expanding the industrial base;
>
> (2) Increasing employment by facilitating industrial use of technology and the manufacturing of new products which result; and
>
> (3) Enhancing the competitive position of U.S. products in world markets.

The emphasis of the proposed legislation is on State participation in technical services programs, planned locally, and designed specifically to place findings of science and technology in the hands of local businesses and industries."

Most funded activities in the program are carried out by designated state agencies under federal grants that provide matching funds for approved projects. The designated state agency prepares and submits to the Office of State Technical Services (OSTS) a five-year plan and an annual technical services program that has been certified by the state governor to be consistent with the policies and objectives of the state. These programs must, of course, follow the technical guidelines issued by OSTS and conform to the STS Act of 1965.

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* *State Technical Services Act of 1965*, 89th Congress, Report No. 817, pp. 1-2.

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In most cases, these proposals have been funded with only minor revisions suggested by OSTS. Each state program, therefore, has been viewed by an evaluator as a small-scale experiment to demonstrate one or more approaches to technology transfer within a specific business and economic climate, despite the fact that the programs were not operated as experiments.

The STS program was reviewed by The Public Evaluation Committee appointed in accordance with the STS Act of 1965. This committee recommended to the Secretary of Commerce improvements in the STS program, and modifications to the State Technical Service Act.*

1. The Transfer of Technology

In our view, technology transfer means carrying specific technological know-how from a source to another point where it is applied. In many cases, the new applications may serve a completely different purpose than the one for which the technology was originally developed. Obviously, technology transfer is as old as civilization itself, and historically it has been accomplished almost routinely as an instrument of business enterprise. Nevertheless, it is difficult to assert with complete confidence how technology transfer can best be effected in this era of rapid technological change.

Furthermore, no satisfactory criteria have yet evolved for evaluating the economic effects of technology transfer activities. To be sure, there is overwhelming evidence of a direct causal link between technical progress and economic development, but establishing such a cause-and-effect relationship in a particular case is difficult. Moreover, technology transfer cannot be considered complete until the new technology, or a modification of it, is put into practice; this may well be a long and involved process, particularly if the technology is advanced. The

* *Growth Through Technology*, final report of the Public Evaluation Committee for the State Technical Services Act of 1965, presented to the Secretary of Commerce of the United States, November 14, 1968.

barriers to technology transfer programs are not just technical in nature: factors like financial risk, politics, fear of change, legal restrictions, marketing problems, and sheer inertia may block completion of the transfer and thus weaken or negate its economic effect. In addition, technology transfer rarely occurs along logical directions which can be definitively planned in advance.

Technology is generally transferred by either supplying specific units of technology to potential users (information dissemination), or by identifying problems and then finding or adapting the technology that will solve them. In our usage then, both information services and problem-solving are [illegible] technology transfer. The problem to be solved is most often seen as unique by the company experiencing it. Problem-solving activities cannot successfully be carried out without personal contacts in the field developing trust and responsibilities for both parties in these activities and motivated by personal reward and recognition.

B. PURPOSE AND SCOPE

The Department of Commerce asked Arthur D. Little, Inc., (ADL) to appraise the value of public investment in the STS program and to supply evidence for assessing whether the program -- with or without modification -- merits continued support. The scope of the evaluation has been stated in the Office of Program Planning's Request for Proposal of March 1969 and in the proposal that ADL submitted to that Office March 26, 1969 which stated that we would perform the following tasks by August 22, 1969:

1) Select samples of Office of State Technical Services (OSTS) funded activities carried out by designated state agencies,

2) Design interview procedures and analyses that can be used to identify and quantify the economic and other benefits of an objective character that resulted from each project,

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3) Determine the variables associated with high and low achievement of objectives,

4) Analyze the effectiveness of OSTS activities and establish cost benefits based on degree of industrialization, type of activity, type of technical dissemination, and type of client served,

5) Compare present OSTS activities with other existing technology transfer activities,

6) Formulate recommendation for improvements in the current program, assuming continuation of the existing level of funding,

7) Establish the appropriate level of funding for the program and determine whether the current program can be justified on solely economic grounds, and

8) Develop procedures, information requirements, and cost guidelines for continuing evaluation as an integral requirement of future OSTS projects supported by public funds.

C. APPROACH

On the basis of the understanding developed through our experiences with technology transfer, we established what information would be most valuable to those interested in the results of our evaluation. In the absence of formalized procedures within the STS program designed to generate the required data, we developed questionnaires, interview guidelines, and analytical procedures as the basis for a realistic and useful assessment of the program. (See Appendix)

We conducted a detailed evaluation of the program within nine states — Arkansas, Georgia, Illinois, Michigan, Oregon, South Carolina, Utah, Vermont, and Wisconsin. To obtain a varied and representative sample, we selected these states on the basis of the following factors:

Geographic location,
Nature of industry,
Dynamics of industry,
Income distribution,
Program image,
Program content, and
Population factors.

When we began our evaluation, the states participating in the STS program formed a committee composed of a number of state program directors. They offered us their cooperation, which we accepted, with OPP concurrence, as a way of obtaining useful feedback on the information developed in our evaluation.

We asked each of the nine selected states to choose the ten most successful cases of technology transfer achieved by the program in that state. We defined a case as an interaction with a user organization about a specific and identifiable subject, such as a problem or need. While the states were selected for examination on the basis of the different factors listed, the cases within each state were selected for the greatest possible success, in the view of that state. We reasoned that detailed evaluation of a small number of the most successful cases would be the most easily measurable indicator of overall results achieved in a state. Random sampling of cases would be costly and perhaps misleading because the percentage of successful cases might in fact be small.

With the assistance of the state program directors, we arranged to conduct detailed interviews with persons concerned with the selected cases. We sought detailed and verified information on who was helped in each case, in what way, and what the specific technical and economic effects were. In our interviews we obtained confidential information from the company and STS personnel involved, as well as university or other technical people who had played a role in the case or had been a direct witness to events.

Results obtained are summarized in Chapter III of this report, and presented in Appendix C.

We submitted questionnaires not only to the nine selected states but to all the participants in the STS program (See Appendix C). The questionnaires were designed to obtain information about program activities, response to the program funding, and administrative procedures. We interviewed representatives of the OSTS, Office of Field Services, Economic Development Administration, Federal Clearinghouse, and the Office of the Assistant Secretary for Science and Technology to obtain their views of the STS program and to inform ourselves about other related Department of Commerce activities. We also consulted with staff members in the Bureau of the Budget.

II. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

A. SUMMARY

Our evaluation of the STS program shows it is providing a useful and economic service in transferring technology which substantially benefits the nation. The program can be made more effective and costs reduced by concentrating the federal and state investments in efforts and services which yield the most returns. We recommend that the STS program receive continued Federal and State support with increasing emphasis on direct service to industry.

Detailed conclusions and recommendations are supported and amplified in the following sections.

B. CONCLUSIONS

1. Federal Support Justification

- The program should receive federal support because:
  - Risks of innovations necessary for industrial growth are spread across a large number of companies;
  - Increased tax returns are obtained from successful innovations which the program helped develop; and
  - Social benefits are an important product.
- A major block to innovation by small firms with limited technical resources is the high risk associated with the cost of technical assistance in solving problems.
- A major contribution of the program to economic development is the distribution of the costs of high-risk innovation.

3. Program Benefits

- The program is meeting its goals by providing technical services which result in both primary and secondary economic and other benefits to the nation.
- In general, the program produces economic benefits which are greater than its cost, but the benefit-to-cost ratio can be improved.
- We estimate that expected tax returns to federal, state, and local governments based on increased economic activity generated by the program will cover its cost.
- Most of the successful cases interviewed produced significant secondary economic and social benefits in addition to primary benefits, such as increased sales and new jobs, and cost savings.
- The program has been most helpful to small and medium sized firms which do not have broad technical and research capabilities.
- The program has provided useful technical services to firms who would not or could not pay for such services.
- An important effect of the program is increased awareness by program users of external technical resources and how to apply them.

3. Program Content

- Field services, including referral, are the most valuable part of the program. Information and educational services are secondary and discretionary activities.

- In each year, a few successful cases will produce most of the benefits, while the majority of cases produce little or no benefit, which is typical of activities involving innovations.
- It is not possible in most cases to predict whether a user will benefit from services.
- Technology transfer was an important ingredient in almost all interviewed cases. The technology transferred was seen as new and valuable to the user, although it may have existed elsewhere for some time.
- Problem-solving services provided under the program do not conflict with those available from other private or public sources.
- Successful STS program personnel are aggressive risk-takers who are willing and able to make informed judgments on technical and business issues, and to commit resources in situations where a successful outcome cannot be predicted.

4. Areas for Program Improvement

- Communications between states can be improved to facilitate more complete exploitation of useful results and techniques. The OSTS has a unique contribution to make in such communication.
- The program only partially benefits from other Department of Commerce activities which are directed to stimulating the growth of the economy.

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C. RECOMMENDATIONS

The information we have obtained and the conclusions drawn from them have led us to make the following recommendations:

1. The program should be retained and federal support continued.
2. Problem-solving services to industry which do not participate in federally-sponsored R&D programs because of small size or nature of industry should be the central activity of the program.
3. Field services which are oriented towards problem-solving should receive increasing emphasis through increased budgets and more personnel.
4. Education, information services, and demonstrations should be de-emphasized and only used as discretionary activities in support of need-oriented field services.
5. Federal funding levels should be increased gradually in a manner which permits new personnel to be adequately trained.
6. The funding formula for the states should be revised and expanded to take into account need factors, as well as performance.
7. The OSTS should design and institute a management information system to provide continuing evaluation of program effectiveness and direction, particularly with respect to economic effects and benefits.
8. The OSTS should play a stronger role in defining and guiding program activities and methods, including program evaluation.
9. The Department of Commerce should establish regional offices for improved communication and coordination of activities between the states.

10) Organizational and geographical location of STS field offices should be reviewed in the light of increased emphasis on field services.
11) The state directors should have more flexibility in the use of funds.
12) The Department of Commerce should review other activities (such as documentation, information, and educational services) which parallel the services of STS to eliminate duplication and promote increased working cooperation.
13) The Department of Commerce should continue to obtain interview-based case histories and comparative economic studies to determine the economic benefits resulting from industrial innovations and how to maximize them through technology transfer programs.

III. RESULTS OF EVALUATION

The method of evaluation used interviews and questionnaires for fact-finding. The variable and complex nature of the STS activities did not permit us to come to any a priori conclusions, but rather, required a concerted effort to establish economic effects in the different states. The information obtained was reviewed and analyzed in terms of economic effects. We used statistical methods (based on the results obtained in the interviews) to project economic effects to an entire state program, and to the 50 state programs.

A. SELECTED CASES

We placed the greatest emphasis on factual material obtained through direct interviews. Memoranda concerning each interview were prepared (as many as seven or eight interviews were held concerning a given case) and three of the most successful cases are summarized below.

1. Vermont Case No. 1

Federal and state water pollution legislation forced cheese manufacturers to discontinue dumping whey into Vermont rivers and streams as of January 1, 1969. When the STS director in Vermont learned of the potential impact of the legislation which would have resulted in bankruptcy or closing down for some cheese producers and curtailed operations for others, he funded a small study at the University of Vermont on the feasibility of converting the liquid whey into a dried, edible product. The results of the study were favorable, and, with these findings, he was able to:

- Attract a major food processor into the state who possessed the required technology to operate the drying plant,
- Organize the 18 cheese manufacturers into a cooperative group that agreed to supply whey,
- Arrange $2 million in federal grants and loans to the project, and

- Provide leadership, direction, and coordination to the project.

Aspects of annual economic effects include:

- 54 new direct jobs created at the whey plant, with an annual payroll of $464,800 based on sales of $1,440,000 of dried food grade whey per year,
- 51 jobs saved at 4 cheese plants which would otherwise close down (payroll $255,000),
- 28 new jobs created by increase in cheese production -- payroll $255,000,
- $454,800 in new federal, state, and local tax revenue generated,* and
- 119 new jobs in secondary employment.

Most of the primary and secondary employment will occur in Franklin county, an area with serious unemployment problems.

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* Federal, state, and local tax revenues as estimated in "Differential Economic Impact Analysis of a Proposed Central Whey Drying Plant in Vermont" by Fife and Nilson** are as follows:

Franklin County property tax	$109,800
Property tax increase due to expansion	18,000
State corporate income tax	15,000
Personal income tax increase	40,000
Federal corporate tax	150,000
Federal personal income tax increase	121,500
TOTAL	$454,800

** C.L. Fife and K.M. Nilson, "Differential Economic Impact Analysis of a Proposed Central Whey Drying Plant in Vermont." Unpublished report.

No estimate has been made of the economic or other benefits from removing the pollution from Vermont rivers and streams. However, the cost of a sewage disposal plant which would have been required to process the whey is about $30 million, plus about $400,000 per year for operating cost.

2. Georgia Case No. 2

A firm which bottles soft drinks and preserves decided to switch to plastic bottles for its soft drink line, believing that the plastic bottles would be cheaper, safer, and more appealing to the consumer. However, after production had begun, the bottles began to leak.

The firm tried various remedies, none of which worked. It appealed to the plastic manufacturers, the container companies, and group after group of engineers, but to no avail. Finally, it contacted the Georgia STS group. Because of the agricultural nature of the product line, a delegation from the University of Georgia was sent to investigate the problem, but it was unable to solve it. A second contact was arranged by the Georgia STS with the Industrial Development Division (IDD) at Georgia Tech. A field engineer was sent and he redesigned the bottle closure, thus solving the leakage problem.

The solution of this problem enabled the firm not only to expand its production and sales of soft drinks because of increased consumer acceptance, but also to increase its area of distribution due to lower freight costs on the lightweight plastic containers. The differential in sales from the use of plastic rather than glass bottles amounted to an estimated $1,000,000 in the first year.

In addition, the plastic bottle supplier in Ohio, which has agreed to manufacture the new design, has received a firm $140,000 order for the bottles. As a result of this order, it plans to establish a new plant in the Atlanta area that represents an investment of $200,000.

Before success had been demonstrated, the manufacturer stated that a small firm like his cannot afford to use consultants when results are

not accepted. Now he has modified his stand and signed a contract for $15,000 for further development work at Georgia Tech.

D. Arkansas Case No. 3

This case involves service to the developer of an automatic catfish feeder. Catfish raising in artificial lakes has become an important business in Arkansas. Until recently, the fish have been fed by distributing meal or pellets by hand, a time-consuming and expensive process. The subject of this case, a successful catfish farmer, invented an automatic blower-type feeder which can be mounted on a tractor. If the tractor is driven slowly along the bank, the feeder spreads an even, economical distribution of feed out to the fish. It saves labor, conserves feed, and reduces overcrowding and nonuniformity of fish size.

The inventor had produced a hand-made working model, but needed help to commercialize the feeder. The STS field agent studied the situation and recommended that he develop reliable production cost data on the device, and also optimize its design on the basis of available information on how catfish should be fed. The agent then developed the needed cost information, as well as the marketing requirements and design specifications. He tested and calibrated the finished device and worked out operating specifications. Finally, he helped the inventor to find a suitable manufacturer in Pine Bluff and then set up an equitable agreement between the inventor and the manufacturing firm.

The inventor estimates that, over five years, machines will be used on 100,000 acres of catfish farms at one machine per 50 acres. He expects to capture 40% of the market and sell 800 machines at a selling price of $1,000 each, or total sales of $800,000.

The services provided by STS were crucial to the commercial development of the catfish feeder. The inventor had little sophistication or previous experience that would allow him to make needed decisions and develop necessary information for the development of the feeder. He did not have the money to hire a professional consultant and believed that a small businessman, like himself, was safer dealing

with a state organization than with private consultants or manufacturers.

B. THE STS CONTRIBUTION FACTOR

In analyzing the interview material, only claims that we could substantiate were accepted and minimum figures were used when in doubt about the economic effects of the STS program. The "STS Contribution Factor" represents our judgment of the importance of the contribution of STS services to improvements achieved by a company in its operation. In no case did we assume that an STS contribution was the only crucial factor in a company's performance, even if it did have a major effect. Company performance depends not only on the STS contribution but also on many other factors -- not the least of which is the contribution of the company's own personnel.

The size of the STS Contribution Factor which we assigned in a given case depends on whether the services performed were passive or active. Table 1 identifies typical services and indicates the relative size of the factor associated with these services. The magnitude of the STS Contribution Factor was determined by discussing the case with the interviewer and applying the judgment of several senior ADL staff members.

C. ECONOMIC EFFECTS

Table 2 summarizes interview results in the nine sample states, and presents the positive economic effects that the STS service had on individual companies. The major business features of these companies are listed in Table 3 (arranged by magnitude of economic effects as shown in Figure 1). The economic effects fall into the general categories of sales, savings (in costs or jobs), loss prevention and investments. To compare the different cases and to make projections, we expressed the economic effects in dollars of sales, using the averaged conversion figures appropriate to the different categories and industries prepared by *Fortune* magazine.[a] The useful lifetime effects were

[a] "The Fortune Directory of the 500 largest U.S. Industrial Corporations who did best (and worst) among the 500," *Fortune*, June 15, 1968, p. 204.

TABLE 1

EXAMPLES OF STS CONTRIBUTION FACTOR
(Arranged in Increasing Order)

Type of Service	STS Contribution Factor (%)
Providing the name of a specialist	0% to 25%
Sending general or background literature	
Referral to specific information or specialized information service	
Participation in combined diagnosis and planning activity	25% to 50%
Preparing detailed plan for use of solution	
Convincing or selling client on need for a particular change and facilitating change	
Coping with strong resistance from one or more places	
Inventing, devising or developing solution to client's problem	50% to 75%
Providing leadership, taking responsibility and demonstrating solution	

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TABLE 2

ECONOMIC EFFECTS FOR INTERVIEWED CASES

Sample State	Case (#)	Type of Effect	First Year Effect ($000)	Estimated Useful Lifetime (yrs)	Estimated Useful Lifetime Effects ($000)	STS Contribution Factor (%)	Discounted STS Useful Lifetime Effect ($000)
Arkansas	1	Sales	400	5	7,800	15	1,170
	2	Sales	430	5	2,150	20	430
	3	Sales	3	5	800	25	200
	4	Sales	90	3	2,850	10	285
Georgia	1	Savings	145	5	835	10	84
	2	Sales	1,000	4	4,000	10	400
	3	Sales	140	4	560	5	28
Illinois	1	Savings	650	1*	650*	100	650
Michigan	1	Loss Prev.	10	1	10	60	6
	2	Sales	1,000	4	4,000	20	800
	3	Sales	200	4	800	5	40
		Savings	4	4	14	10	2
Oregon	1	Sales	40	2	80	5	4
	2	Loss Prev?	12	1	12	30	4
	3	Loss Prev.	7	1	7	10	1
	4	Savings	4	6	25	50	13
South Carolina	1	Sales	250	4	1,000	30	300
	2	Savings	5	3	15	30	5
	3	Sales	1,300	4	5,200	30	1,560

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TABLE 3

FIRMS INTERVIEWED

	Code	Type of Company	Annual Gross Sales
	Arkansas #1	Feed mill	$ 1.5 million
	Arkansas #2	Feed mill	$ [illegible] million
	Arkansas #3	Private inventor	Not applicable
	Arkansas #4	Laser grading equipment	$ 1.4 million
	Georgia #1	Brick manufacturer	(28 employees)
	Georgia #2	Food processing and packaging	$ 3.0 million
	Georgia #3	Container manufacturer	Not available
	Illinois #1	Computer services to construction industry	Not applicable
	Michigan #1	Building system supplier	$ 1.0 million
	Michigan #2	Instrument manufacturers	$ 1.0 million
	Michigan #3	Power transmission equipment	$ 0.6 million
	Oregon #1	Individual fisherman	Not applicable
	Oregon #2	Individual fisherman	Not applicable
	Oregon #3	Individual fisherman	Not applicable
	Oregon #4	Oregon coast fisherman	Not applicable
	South Carolina #1	Iron and steel company	$ 8.0 million
	South Carolina #2	Canvas products	$ 3.0 million
	South Carolina #3	Synthetic yarns	$ 7.5 million
	Utah #1	Wig manufacturer	$ 0.3 million
	Utah #2	Patient monitoring equipment, fluidic systems, machine parts	$ 0.415 million
	Utah #3	Optical instruments (small company)	Not available

TABLE 2

ECONOMIC EFFECTS FOR INTERVIEWED CASES (cont'd)

Sample State	Code (b)	Type of Effect	Firm's Year Effect ($000)	Estimated Useful Lifetime (yrs)	Estimated, Useful Lifetime Effects ($000)	STS Contribution (%)	Discounted STS Useful Lifetime Effect ($000)
Utah	1	Savings	10	2	35	50	18
		Sales	25	2	90	10	5
	2	Savings	0.3	1	0.3	50	-
	3	Savings	3.5	1	3.5	5	-
		Sales	100	3	300	10	30
Vermont	1	Sales	1,440	5	7,200	20	1,440
		Sales	255	5	1,275	40	510
	2	Sales	140	4	560	40	224
		Savings	6	6	36	30	11
		Less Freq.	7	1	7	30	2
Wisconsin	1	Savings	25	5	125	5	6
	2	Sales	2,500	1	2,500	1	25
	3	Savings	1,000	1	1,000	1	10
	4	Savings	350	1	350	5	18

[illegible]Since continuing costs occur along with continuing effects, effects are measured on annual basis only.

TABLE 3 (cont'd)

Code	Type of Company	Annual Gross Sales
Vermont #1	Whey drying plant	Not applicable
Vermont #2	Drilling, structural steel products	$ 4.8 million
Wisconsin #1	Rubber	$ 1.5 million
Wisconsin #2	Stainless steel	$ 2.3 million
Wisconsin #3	Industrial products	$375.0 million
Wisconsin #4	Electronics manufacturers	$100.0 million

FIGURE 1 ECONOMIC EFFECT BY CASE

discounted by applying the appropriate STS contribution factor. The useful lifetime for a case was assumed to be the average lifetime of a product in the business area applicable to the case. Table 4 shows our estimates of these useful lifetimes. The useful lifetime effect in several cases was larger than a straight line estimate would have indicated.

Figure 1 presents the economic effects arranged by magnitude of the cases. The type of service rendered by STS is also indicated. A small number of successful cases account for the largest economic effects, with field services being the dominant STS activity. In the nine sample states, we found that successful cases were only a small percentage of the total number of cases. Modifications in program operation or funding can be expected to influence the number of successful cases, although the general distribution pattern is likely to remain the same; this is indicative of high risk innovative activities.

We designed a statistical projection procedure (See Appendix B) for extrapolating the results of interviews in the nine sample states to obtain: 1) the aggregate economic effect for the first year in which such an effect was obtained; and 2) estimates of the aggregate economic effect for the lifetime of a case. The statistical procedure was based on a log-normal distribution function which has been used to predict similar events (See Figure 2). This distribution provides minimum projections for economic effects.

Table 5 summarizes the first year and lifetime economic effects extrapolated from the interviewed cases to the individual sample states for comparison and evaluation. The table also shows the combined federal and state budgets and the federal budgets for 1969.

Figure 3 shows that the ratio of program expenditures to economic effects (lines 1 and 2) for the successful cases (which made up the bulk of economic effects generated by the program in the sample states) is far larger than the ratio of overall costs to economic effects (lines 3 and 4) in the same states. Because there is no way of pre-

TABLE 4

EXAMPLES OF USEFUL

LIFETIME ESTIMATES

	Years
CONSUMER PRODUCTS	
Basic Foods	4
Clothing, Fabrics	2
Packaging & Containers	2
Cosmetics	1
Toys, Novelties	1
INDUSTRIAL PRODUCTS	
Structural Steel	6
Heavy Machinery	5
Chemicals	4
Building Materials	3
Electronics	2
Instruments	2
SERVICES	
Insurance	6
Computer Services	3

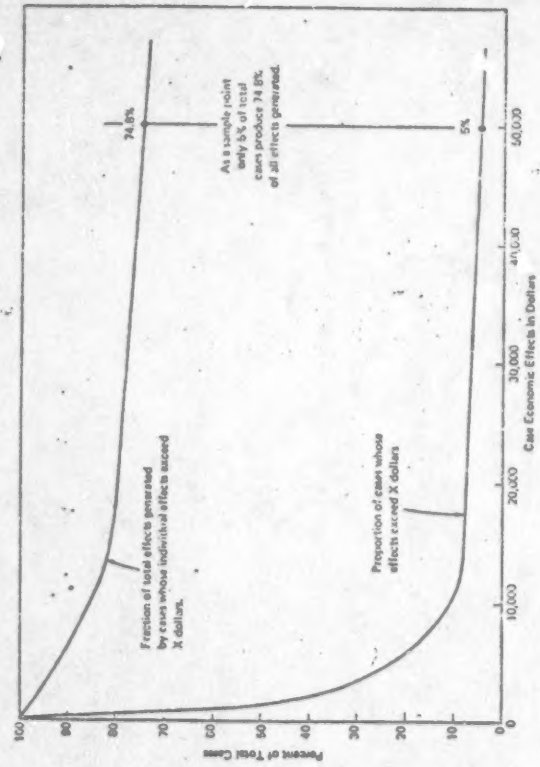

FIGURE 2 DISTRIBUTION OF CASE ECONOMIC EFFECTS
(Log Normal Distribution)

TABLE 5

ECONOMIC EFFECTS IN SAMPLE 9

(Translated to Increased Sales
Thousands of Dollars)

	First Year State Aggregate	Useful Lifetime Aggregate	Total '69 Budget	'69 Federal Budget
Arkansas	294	2,838	153	70
Georgia	620	4,457	214	107
Illinois	1,625	1,625	753	200
Michigan	522	1,628	393	197
Oregon	234	619	138	69
S. Carolina	631	2,477	154	77
Utah	233	785	165	59
Vermont	1,264	3,814	153	66
Wisconsin	1,279	1,313	198	97
Totals	$6,702	$19,756	$2,321	9942

$22 +- 1

dicting where field services will have the most significant effects, activities have to be spread over many cases requiring a proportionally larger expenditure.

The ratio of the entire STS program budget ($10,878,000) to the nine-state budget ($2,321,000) is 4.7. Using this ratio, the entire program one-year aggregate economic effect would be projected as $31,412,000 and the useful lifetime aggregate economic effect would be $92,596,000.

These projections are useful in a gross sense only. Our interviews in the nine sample states showed wide variation in techniques and procedures, and we have no reason to expect uniformity in the other states. Therefore, we feel that more accurate estimates of results in any state must be based on interview in that state.

Our evaluation explored some new ground in the assessment of activities designed to produce economic effects. We believe that the results are useful as a guide for the evaluation of programs such as the STS when no program results are available. Many of the approximations we used out of necessity can be refined to greater accuracy in the future and a system designed to collect appropriate data.

FIGURE 3 RELATIONSHIP OF PROGRAM EXPENDITURES TO ECONOMIC EFFECTS

IV. IMPLICATIONS OF THE EVALUATION FOR THE STS PROGRAM

A. BENEFITS OF THE STS PROGRAM

In discussing results obtained through STS participation,[a] we have distinguished between effects and benefits. An economic effect is a change in economic activity, i.e., sales of goods and services, including labor, real property, barter, trade, loans and investment, stocks and bonds, personal and professional services, entertainment, taxes, and government expenditures.

An increase in one region that is a result of a decrease in another region is considered a net effect (i.e., losses cancel gains). Economic effects are usually directly observable and readily quantifiable.

An economic benefit is a positive net effect upon the society at large expressed within the intent of the State Technical Services Act in terms of Gross National Product, employment, and increased competitiveness of U.S. products. In addition, we believe that upgrading of products, services, labor, wages, and environment are examples of other benefits. "Almost without exception, technological developments will affect some people or interests adversely and others beneficially, and there simply is no agreed-upon algebra by which one can neatly subtract the pains from the pleasures in order to arrive at a net index of social desirability."[aa]

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[a] The State Technical Services Act is concerned with promoting benefits in the terms we have used here and does not permit support of "..... services specially related to a particular firm or company, public work or other capital work except insofar as the services are of general concern to the industry and commerce of the community, State, or region." *State Technical Services Act of 1965*, 89th Congress, Report No. 817, p. 9.

[aa] "Technology: Processes of Assessment and Choice," *Report of the National Academy of Science*, July 1969, p. 29.

"Innovation is the keystone of a strong economy and incentives for innovation are justified by the broad social benefits engendered by technological progress. This position has long been supported by economic theory, and, recently, by empirical evidence. Indeed, research by Joseph Schumpeter supports the fundamental conclusion that entrepreneurial innovation is the wellspring of economic growth."* Modern econometric studies indicate that more than 80% of the growth in output (GNP) in the United States from 1909 to 1949 must be attributed to innovation and efficiency.**, †

Benefits may be primary; that is, direct and immediate consequences of action taken or they may be secondary, indirect, and not an immediate consequence. Both primary and secondary benefits must usually be inferred, rather than observed. Secondary economic benefits might include the following:

- Increasing the general competitiveness of American industry,
- Economic development of regions,
- Improving the level of technology and increasing the efficiency of American industry, and
- Improving or increasing application of scientific or technical knowledge and procedures.

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* J. A. Schumpeter, *The Theory of Economic Development*, Harvard University Press, 1936, and "The Creative Response in Economic History," *Journal of Economic History*, Nov. 1947, pp. 149-59.

** R. M. Solow, "Technical Change and the Aggregate Production Function," *Review of Economics and Statistics*, Aug. 1957, Vol. 39, pp. 312-320.

† I. M. Plotkin, "The Consequences of Industrial Regulation on Profitability, Risk Taking, and Innovation," A statement submitted to the Interstate Commerce Commission on behalf of Sea Land Service, Inc., *Arthur D. Little, Inc., Report*, June 1969.

The cases examined in our study varied in the degree of innovation involved. While the primary economic effect may not be a direct function of innovation, the secondary benefits appear to increase as innovation increases. Thus, in South Carolina Case No. 1, where the STS provided an industrial engineering analysis of a structural steel production facility, little or no innovation occurred, and benefits are probably rather narrowly confined. On the other hand, in terms of changing the way people do things, the innovative impact of Vermont Case No. 1, where a whey-drying plant is under construction in Franklin county, is quite large and the secondary benefits (e.g., secondary equipment, removal of pollution, probable increase in tourism, and economic development of a poverty area) are very significant.

1. Economic Benefits

The increased sales received by companies as a result of STS program services may be regarded from a national or social point of view as related (through the portion of the increase in sales which represents an increase in value added)* to the GNP. From a social point of view, an increment to GNP is the most widely used accounting measure of the merit of an economic activity and is used as one of the performance criteria as we have interpreted the State Technical Services Act. Other criteria, such as increased employment and enhancement of the competitive position of U.S. industry, while desirable, are not readily measurable in the cases examined. To produce the estimate of the increase in GNP, the increase in sales was multiplied by the ratio of value added to value of shipments. (See Table 6.)

Evaluating a case in terms of its contribution to gross national or state product also permits generalization as to the increase in federal, state, and local revenues likely to be produced by the increase

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* Value added is the contribution of an industry to GNP since it is the sum of wages and salaries, depreciation, rents, profits, and indirect business taxes. It is the measure of the net addition to GNP by a productive process.

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TABLE 6

RATIO VALUE ADDED TO VALUE OF SHIPMENTS

	Value Added By Manufacturer	Value of Shipments	Ratio VA/VS
Arkansas	1,568	3,827	0.410
Georgia	5,034	11,876	0.424
Illinois	20,045	41,843	0.479
Michigan	17,297	39,407	0.439
Oregon	1,961	4,451	0.441
South Carolina	3,035	6,456	0.470
Utah	750	1,665	0.450
Vermont	486	1,101	0.441
Wisconsin	7,062	15,811	0.447

1967 Census of Manufacturers: General Statistics for Geographic Divisions and States, U.S. Dept. of Commerce

in GNP. In 1968, approximately 14.5% of the GNP of the United States was received as net tax payments by the federal government. Contributions to social insurance (transfer payments) have been excluded from government receipts. In addition, state and local government receipts are net of federal grants. State and local government receipts constituted 9% of GNP in 1968. Thus, insofar as the increased value product of the sample companies is typical of their respective states, the enlarged activities within the nine states in which interviews were conducted may be expected to generate approximately $1,254,000 in federal government tax receipts, and $783,000 in state and local government tax receipts.* (See Table 7.)

Rough estimates of the additional employment provided in the nine sample states can also be inferred from overall GNP aggregate for 1968. In that year, the value of GNP per employed member of the labor force was about $11,200.** This dollar amount of GNP per worker applied to the additional sales recorded for the sample states indicates that (if the successful companies are typical of the nation as a whole in this one respect) about 600 additional jobs may have been created as a result of their enlarged activities. Table 8 shows the increased employment calculated from the increase in value added in each state.

In very few instances the program provided services which contributed to increased economic activity in one area that were reflected in a decrease in another area (e.g., location of an electronics company to utilize STS information services in one state rather than in a neighboring state which did not concentrate their program effort in these activities). Such application of STS services, while in accordance with the STS act, contribute only marginally to the nation's economic development. They can be avoided in the future by instructing field agents to concentrate their efforts on activities which assist industry to introduce

* The national numbers used were taken from *The Economic Report of the President* transmitted to the Congress Jan. 1969, Appendix B, Tables B-1, B-23, and B-63.

** United States employment throughout 1968 averaged 75,920,000 persons.

TABLE 8

EMPLOYMENT EQUIVALENT OF GROSS NATIONAL PRODUCT INCREASE

State	Increase in Sales Useful Lifetime State Aggregate ($000)	Less* Savings ($000)	Increase in Sales Only ($000)	Increase in GSP ($000)	Primary Employment Equivalent (No. of Jobs)
Arkansas	$2838	$ 0	$2838	$3164	104
Georgia	4457	1246	3211	1361	122
Illinois	1625	1421	204	98	9
Michigan	1628	215	1513	644	59
Oregon	629	531	88	39	3
South Carolina	2476	106	2370	1114	99
Utah	785	431	354	159	14
Vermont	3814	196	3618	1596	143
Wisconsin	1513	661	852	381	34
	19,755	4707	15,048	6576	587

* Total savings is a mixture of savings from the reduction of various factors of production including labor. In order to produce a deliberately conservative estimate of net primary employment created by the increase in value added, all savings were subtracted from it. This is probably overly conservative in that whatever labor was saved would be unlikely to remain long unemployed.

Sources: *The Economic Report of the President*, January 1969, and Arthur D. Little, Inc., estimates.

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TABLE 7

FEDERAL COVETOUSNESS ACCEPTS

State	Increase in Sales Useful Lifetime State Aggregate ($000)	Corresponding Net Contribution to Gross National Product* ($000)	Federal Receipts @ 14.5% ($000)	FIS Federal Budget 1969 ($000)	State and Local Receipts @ 9% ($000)	FIS 1969 State Budget ($000)	Total Receipts ($000)	Total '69 Budget ($000)
Arkansas	$ 2,838	$ 1,164	$ 169	$ 70	$ 105	$ 83	$ 274	$ 153
Georgia	4,457	1,890	274	107	170	107	444	214
Illinois	1,625	738	113	200	70	333	183	733
Michigan	1,628	715	104	197	64	197	168	394
Oregon	619	273	40	89	25	69	65	138
S. Carolina	2,476	1,164	169	77	105	77	274	154
Utah	785	353	51	39	32	106	83	165
Vermont	3,814	1,682	236	66	151	87	387	133
Wisconsin	1,513	676	98	97	61	101	159	198
Aggregate States	$19,755	$ 8,685	$1,254	$942	$ 785	$1,380	$2,037	$2,322

*Obtained by multiplying column one by $\frac{TA}{VS}$ from Table 6.

1969 Total Budget for all Programs: ($10,878,000,000)

innovations in terms of new products, processes, and services and new business activities. The difference between economic benefits produced by a new venture as opposed to a relocated one or one which is made more competitive is, of course, a matter of degree. Continuing evaluation of the STS program should permit deliberate guidance of program services by crediting economic benefits to the STS program which are not just displaced from one location to another.

2. Secondary Benefits

In addition to measurable economic benefits, projects may have secondary noneconomic benefits that can be identified but not quantified. These secondary benefits must be considered in any evaluation of a program.

In many of the cases studied among the smaller and technically less sophisticated user firms, learning the techniques and resources of technical problem-solving was an important secondary benefit. Some of the users, as a consequence of receiving help, started efforts to solve other problems facing them by searching out information sources, consultants, etc. Table 9 presents typical secondary benefits we found to be produced by STS program activities.

Benefits like those shown in Table 9 can be an important gain for society. For example, in Vermont Case No. 1, reducing pollution and producing an edible protein food supplement are both socially and economically desirable. Program services should be designed to support activities expected to result in such benefits. The success of the program should be gauged not only by its economic consequences but also by its contribution to the public good in ways that are not necessarily reducible to economic benefits.

PUBLIC SUPPORT FOR PROGRAM

A major question that has been raised about the STS program is: if the program is successful, why should the federal government (rather than the states or industry within the states) support the program? The answer to this question is, of course, intimately tied to the bene-

TABLE 9

TYPICAL SECONDARY BENEFITS OF THE STS PROGRAM

Program	
Vermont #1	Reduction of pollution in Vermont rivers and streams.
	Potentially increased tourism.
Illinois #1	Increased efficiency in construction industry.
	Use of Illinois-developed computer program in other states.
Arkansas #3	Availability of more efficient fish-feeding methods.
	Awareness of business procedures and product development techniques by private developer.
Oregon #4	Organization of fishermen into group for sharing information and pooling resources.
Georgia #1	Improved knowledge of available techniques in brick manufacturing.
Georgia #2	Awareness of a variety of problem-solving services and resources.
Utah #1	Awareness of wide range of low-cost replacement materials.

fits that result from the program. Unlike the programs of state development commissions, the STS program is concerned more with creating new activities that will produce benefits for society as a whole than with displacing an activity from one place to another or improving the competitive position of a particular company or segment of industry.

In a number of states, the development department is the designated agency and might tend to emphasize these displacement effects, which are generally easier to produce, rather than innovative activities. With an STS program carried out on a national scale with federal support and guidance, there is better chance to produce benefits for an entire region or the nation as a whole. The federal government can assess the desirability of social benefits and provide incentives for industry to engage in activities which can lead to such benefits. If these activities are left to the states, each state government would emphasize its own political and economic objectives and each state program could be a success with the sum of such "benefits" for the nation equal to zero.

Most small firms are not in a good position to absorb the costs and incur the risks involved in technology transfer. To be sure, private consultants play an important role in disseminating the benefits of new technology to American business; however, many firms have never received problem-solving assistance from an outside source and are reluctant to do so because they cannot afford a single failure in an activity where failures outnumber successes by something like ten to one. These firms often attempt to innovate, but have neither the technical staff to follow through internally or the financial resources to absorb failures. The STS program can afford a reasonable number of failures, if the successful projects produce sufficient primary economic benefits to generate tax returns equivalent to the total program budget, as we have shown they do in some states. These small but innovative firms are perhaps the ones that most need such assistance. For them, the STS program serves as a form of insurance, or risk distribution. Because they are free to the user, the STS services may well encourage these firms to attempt innovations they would not try otherwise.

Federal funds for research and development serve as a springboard for new products and processes for many large firms. The STS program give firms that have not received such federal R&D funds an opportunity to develop new and improved products and processes. There is some evidence to show that many smaller firms are willing and able innovators, but without participation in federal R&D programs or some other form of technical assistance, they can rarely afford or attract the technical staff needed for complex developments.

C. THE RELATIONSHIP OF THE STS PROGRAM TO OTHER PROGRAMS

Several current programs of the Department of Commerce and other government agencies provide services that relate to the STS program.

We found that the cooperation between STS and other various programs — particularly with the Economic Development Administration (EDA) and Office of Field Services — depends on the initiative of local personnel. For example, in Pennsylvania the STS program has very close relationships with the Office of Field Services in Philadelphia, but no contacts with the office in Pittsburgh.

Apparently, there is no overall policy for coordinating the various program components of the field offices of STS, EDA, and Office of Field Services in order to achieve their common objectives. The major difference appears to be that the STS program is supported by federal grants, state funds, and to a limited extent, private funds, while EDA and Office of Field Services are funded and staffed by the Department of Commerce.

Several of the EDA and Office of Field Services staff members we interviewed felt that the activities of the STS program could be absorbed by their programs. However, further discussion showed that EDA and Office of Field Services activities do not parallel the most important activities of the STS program, i.e., direct services that provide problem-solving assistance to industry, primarily on a technical level. The Office of Field Services as the direct representative of the Department of Commerce, makes available the resources and services of the Department and answers technical inquiries with information from the Federal Clearinghouse or Patent Office.

The Office of Field Services estimates that a typical staff member spends 40% of his time in field contacts with industry, whereas the STS field agent spends about 60% of his time in field contact and the more successful his efforts, in general, the more time he spends in direct contact with users. The Technical Assistance Program of EDA is concerned more with planning and programming sizable development projects than with the type of problem-solving carried out by STS. Moreover, in the EDA program technical assistance funds go directly to the applicant (although a maximum nonfederal contribution in cash or kind is sought for each project, so that the federal share does not ordinarily exceed 75%). The ratio of shared expenditure in the STS program is unique among the federal government's current technology transfer activities.

A number of other federal agencies have responsibilities in the area of technology transfer. These include the National Aeronautics and Space Administration (NASA), the Atomic Energy Commission (AEC), the Department of Agriculture (USDA), and the National Science Foundation (NSF). The first two seek to make technology available to industrial users through publications, information services, and industrial cooperation programs. USDA activity is aimed at serving agriculture. In addition to literature and information services, USDA emphasizes local field offices. The NSF is indirectly involved in technology transfer through its concern with improving scientific information systems. It performs research on the communication of scientific information.

D. PROGRAM FUNDING

Since measurements of the program's economic benefits are only now emerging, estimates of optimum funding levels have not been possible in the past. Therefore, overall funding levels for the program have tended to reflect availability of money. The formula for distribution to the states does take into account some need factors, such as population size and degree of industrial development.

The overall program federal funding level* reached in the last full year of operation appears to be sufficient to maintain the momentum of the program. However, there are many more potential users than there are resources to reach them. Because the federal budget could be substantially increased without reducing the ratio of benefits to expenditures, increases should be gradual to insure the efficient training and integration of new personnel in an operation where personal relationships are important. (ADL experience with new staff members suggests that 15% growth per year is a reasonable figure).

The formula used to allocate funds should be revised so that the federal government is better able to support economic development programs in specific regions, assist localities with large numbers of disadvantaged, and provide the states with incentive for achieving state program objectives. This will require the establishment of uniform criteria for measuring program effectiveness along the lines used in this evaluation.

Once such criteria have been established, the various state programs can be compared to determine which ones deserve continued support and which ones should be discontinued. The proposed regional offices would then have a basis for suggesting remedial measures and changes in program organization or content. The criteria would also place OSTS in a better position to review proposals and funding requests. Additional funds can then be allocated to those states which follow suggestions for improving their programs. The fact that the states themselves have been increasing their matching funds (two-thirds of the states increased their contributions in 1968) indicates some degree of state satisfaction with the program's economic and other contributions.

It is often difficult to determine precisely how much a particular state spends on the program. One reason is that some states obtain funds from private sources (e.g., Illinois obtained $533,000 in one year

* Federal levels have remained within narrow ranges, $3,024,999 in 1966, $4,981,939 in 1967, $5,829,995 in 1968 and $4,874,000 in 1969.

from such sources). Moreover, some states (e.g., Arkansas) pool STS funds with funds from other programs, such as ESA.

E. PROGRAM ACTIVITIES

Within the meaning of the Act of 1965, STS program activities can be classified as either information services, educational services, referral services, field services, or demonstrations. All of these activities are potentially useful aspects of technology transfer; however, as we have shown, direct field services which participate in problem-solving are most effective.

Information services are, of course, invaluable for disseminating technology, particularly to companies that lack know-how or a market position in a specific area of technology and do not have ready access to an information center where the information they require can be obtained. However, STS information services should not be considered ends in themselves as we often found. Their primary purpose should be to serve as back up and support to the problem-solving activities of the field agent. In this way, the entire program can benefit from the accelerated development of integrated comprehensive information systems[a] expected in the coming years, particularly, the planned build-up of computerized federal information systems.[aa] For example, more regional information centers that draw upon the federal data base could be set up; these centers could supply information rapidly and at low cost, interpret

[a] $603 million federal expenditure was reported for the collection, documentation, and dissemination of scientific and technical information in 1966. $684 million was projected for 1967 and $760 million for 1968. *National Science Foundation*, "Federal Funds for Research, Development and other Scientific Activities: Fiscal Years, 1966, 1967 and 1968." XVI, Washington, D.C., USGPO, Aug. 1967.

[aa] The *National Academy of Sciences* in the 1969 Report of the Scientific and Technical Communication recommends that the federal government establish a single group to (a) plan a unified program of critical experiments of operational scale in scientific and technical communication and (b) find, guide, and support contractors in the conduct of such experiments.

it for the user, and support the field agents problem-solving activities as needed.[a] And (because of their access to federal data) the centers would not have to spend time and money establishing and cataloging information systems on the state or regional level. Moreover, since information services by themselves are not unique to the STS program, they should be coordinated with activities of other agencies whose primary function is to supply information. As far as the STS is concerned, information should be treated as just one of many available resources the field agent or problem solver may choose to employ.

Educational services accounted for over 25% of the total program expenditures in 1968. (See Table 10). The effect of these services is difficult to evaluate by any accepted indices of economic activity. Like all well-run educational services, they are of value, and the seminars and courses arranged by the program have enjoyed considerable popularity and acceptance by industry. On a practical level, they have been used to aid in marketing of field services, uncovering of problems, and as public relations activities in support of the program and the associated universities. They may also be useful start-up activities in a state with a new program.

Nevertheless, educational services do not appear to be essential to the program's objectives. Although fees can be charged for some of them, the administration and organization of seminars and courses does require considerable program effort. The STS program, therefore, could well de-emphasize -- without completely eliminating -- these services.

One way to do this is make the program a focal point for industry's educational needs in a given area and to encourage state universities, private institutions, and professional societies to respond to these needs. For example, rather than conducting short courses on computer methods, critical path methods, or technological innovations, the state

[a] Regional dissemination centers set up under the auspices of the NASA Technology Utilization Program carry out some of these activities, but are not designed to meet the needs of the STS program.

TABLE 10

FEDERAL STS SUPPORT BY ACTIVITY (1968)

Administration	$ 498,291	
Education Services	1,260,645	$2,409,031
Information Dissemination Services	1,148,386	
Referral Services	403,045	$1,387,082
Field Services	984,037	
Demonstrations	158,604	
TOTAL	$4,453,008	

Source: U.S. Department of Commerce

services could direct interested parties to the almost identical courses that many institutions of higher learning are now sponsoring. Conversely, such institutions could make their special capabilities known to the STS so that industry can be informed of opportunities for obtaining useful scientific and technical knowledge.

Thus, STS could serve as a bridge between industry and universities. To do this, the STS program must encourage universities to view industry as a potential market for their workshops, seminars, short courses, and conferences and offer to publicize such educational programs.

Demonstrations of new technology carried out under the auspices of the STS program may have had some local significance, although none appeared in the interview material. Nevertheless, some projects, particularly of a vocational training nature, could be carried out by state schools. Here again, STS would serve as an intermediary rather than underwriting the cost of such projects.

Within the program there has been growing recognition that person-to-person contacts are the most effective method of technology transfer. As a result, expenditures for field services have been increasing (See Figure 4). A comparison of expenditures shows that for 1968 the total expenditure for educational and information services exceeded the amount expended on field services (including referrals) by about 70%. (See Table 10). A further reduction in expenditures for educational services is projected for 1969, with information services being kept at the same level.

As the results shown in Figure 4 indicate, services that require active participation, such as problem-solving, innovation and entrepreneuring, are more likely to produce measurable effects. Educational and information services, on the other hand, may increase industry awareness of the program, but their economic effects tend to be indirect and difficult to evaluate; moreover, these "less active" activities often seem to duplicate other services provided by the Department of Commerce and other government agencies.

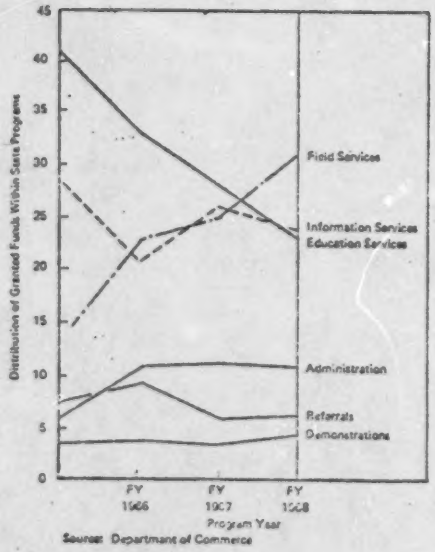

FIGURE 4 STATE PROGRAM TRENDS

We, therefore, recommend increased emphasis on field service work, with educational, information, and demonstration services playing decreasing and secondary roles in support of field services. The proper balance between these activities should be influenced by economic considerations of the kind used in this report and should be integrated into the program decision-making process. For example, the program services can be directed to those problems where secondary benefits are likely to result.

We have not attempted to evaluate precisely where and how the federal technology transfer programs overlap. There appears to be considerable room for greater coordination and cooperation among the various programs. Since nearly all government departments can affect technology transfer to industry, and since one department may be in conflict with another, collaborative policy-making could greatly strengthen the various activities now directed towards that objective.

F. PROGRAM ORGANIZATION

The current organizational structure of the program is a result of funding methods for the program, the considerable variation between state programs, and the limited operational experience and evaluation of the program. The funding methods are somewhat analogous to those used by grant-giving federal agencies to support R&D in industry or academic institutions. As a result, each state exercises a great deal of control over how its program will be conducted, what methods will be employed, and what the emphasis of the program will be. Consequently, the OSTS has played a limited role in program management.

Because each one is somewhat unique, the state programs can be viewed by us as a series of natural experiments in technology transfer — experiments which have been carried out along dissimilar lines and which have produced diverse results. In a sense, the variable nature of the state programs is a virtue because a set of rules governing technology transfer has yet to be established. However, greater control over program content by OSTS might produce more effective technology transfer

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now that we have had some opportunity to evaluate results. Such control will become more and more necessary as it becomes apparent that certain programs result in greater economic benefit and more effective use of funds than others do.

Our contacts with the states have shown that improving communication at every level of the program could greatly add the program effectiveness. For example, one state has designed a management information system in order to decide what actions should be taken in the program, while a neighboring state is in need of such an information system to guide its program actions. In another instance, the problem-solving activity for an industry sector in one state was very similar to activities carried out in another state, but no information passed between the states to help them carry out these activities. The states have no direct incentive to share information. The communication of useful results and techniques in one state to points of application in the others may be a uniquely federal function. But because the OSTS field directors have to interface with a large number of state directors (a ratio of 1:10), they have had little time to work individually with them.

The need for better communication has been recognized, and a number of meetings and conferences to remedy the situation have been held. Still other remedies can be suggested.

The states can be organized into regions that coincide with regions set up for other federal government programs. This regionalization has already begun and its usefulness is being recognized. (Three formal regional programs involved one-third of the states in 1968). The end result should be regional offices that serve as communication points for both the states and the OSTS.

One method by which regionalization could be achieved would be to set up regional offices as part of the offices of the ten STS program directors who are members of the ad hoc committee representing the states participating in the STS program. Each office could serve about five neighboring states as a communication point between these states and OSTS. The ad hoc committee could then become the vehicle through

which the interfaces between the states and OSTS could be more easily established as compared to dealing with 50 STS program offices and directors.

These regional offices could perform such functions as:

- Collecting the data for program evaluation components and suggesting procedures by which the states could make their own evaluations,
- Exchanging information with other regional offices so that activities that have worked in some regions could be adapted and instituted in other regions,
- Coordinating the training of the program staff through the region and working out training procedures with other regional offices,
- Helping the states prepare meaningful proposals for activities and insuring that the program organization within each state is set up to achieve maximum program effectiveness, and
- Coordinating STS programs with other federal programs so that the states can use the services provided under other programs, while remaining responsive to the guidance of OSTS and the Department of Commerce.

G. CONTINUING EVALUATION PROCEDURES

We have evolved a number of approaches, guidelines, and forms for evaluating the program (See Appendix B). Such evaluation should not only serve the internal management of the program, but also guide the actions of the funding agencies. It will be greatly facilitated by establishing a management information system to provide data about program operation, services performed to meet program objectives, and the effectiveness of supporting functions (such as accounting, reporting, marketing, personnel and public relations). These data will enable the

management to plan and control program activities, personnel selection and training, marketing and public relation support, and liaison with outside groups, including the various state offices, the universities, other federal programs, industry in general, and the public at large. Therefore, a management information system should be an integral part of the program. Such a system would have the following purposes:

- Providing management with the information required to make decisions and initiate changes,
- Providing a data base for analysis of economic and other benefits of the program,
- Standardizing the accounting and reporting procedures to permit comparison of different parts of the program within the states, within the region, and within the country,
- Continuing evaluation of benefits provided under the program, and
- Providing useful information for marketing and public relations activities, as well as for personnel selection, training and guidance.

The data for this management information system would be largely supplied by the regional and state offices and would include information on the activities of the field offices, the problems encountered, the results achieved in the program, and the performance of the program participants.

The information generated at the state level or at the regional level should be the basis for quarterly reports and annual reports to be submitted to OSTS. These reports should answer the following questions:

- How many successful cases have been identified and what are their economic effects and benefits?
- Who has been served in terms of size of company, type of industry, type of technology transferred, geographical location, type of service rendered?
- What has been the cost of providing the service, both direct and indirect?
- How much problem-solving activity or other activity has resulted from contacts within the program and outside it?
- Who has contributed to the various activities and services carried out under the program?
- Have the resources been properly utilized and have difficulties been encountered in working with other agencies?
- What modifications are being instituted or requested to improve program effectiveness?
- What marketing efforts and public relations efforts have been undertaken and what has been the effectiveness?
- What is the progress of guidance and training of program participants?

The procedures outlined above will provide the necessary data for a continuing evaluation of program effectiveness and will indicate to Department of Commerce program planners the value of investment in the STS program.

H. LOCATION OF DESIGNATED AGENCY

In each state, a designated agency is charged with directing the program within the state. In most cases, we found that these agencies have offices that are attached either to a state-run agency or to a university. Both situations can create difficulties, although we must not overlook the advantages of cooperation and support from these groups.

We found that an agency which is attached to a state development commission or other state-run agency often sees its goals subordinated to those of the state-run agency. Because the STS programs in the states are relatively small compared to several of the other programs, the state director often finds himself in a weak position regarding the compensation he can obtain and requests for support and services from the state. State agencies are usually quick to support activities that show promise of generating substantial economic benefits, however.

Attaching an STS office to a university produces several positive results. The state director and the field agent are viewed by industry as university representatives and, therefore, find easier acceptance and higher prestige associated with their office. Industry has a high regard for academic institutions, although it may view them as being out of touch with the "practical problems." Moreover, academic institutions possess many of the resources, skills, and knowledge that the program is designed to make available to industry.

However, there is always the danger that a university's goals may conflict with those of the program. Such conflict can affect the conduct and administration of the program adversely, particularly when field agents are located in different campuses of state universities. If the university faculty views the program as irrelevant or contradictory to its own function, it will oppose it. Thus, when an office is located at a university, it is important that the program services do not interfere with the university's major tasks as defined by the university. Not all universities consider seriously their role in support of industry, or agree that problem-solving at the level of

the individual firm is an appropriate way to provide such support.

There is no simple solution to the problem of organizational location and program autonomy. It would be useful to have the support and working cooperation of both the university with its technical resources and various offices of the state government. There are parallel objectives among these organizations to which the STS field office might well provide an effective mechanism for relating efforts. To do so, it must not be controlled solely by the existing goals of the designated agency, however worthy these may in fact be.

Although it may not be possible to retain direct federal administrative control over the program in a state, physical location in a building housing other federally-sponsored programs may mitigate the problem. This would make it easier for the STS program to draw on the services provided by the other programs and would open up personal communications with the staffs of these other programs. As a result, duplication of program efforts could be reduced, activities shared, and the STS program identified with the overall federal effort to foster economic growth and development.

I. PERSONNEL SELECTION AND TRAINING

One of the most significant features of the STS program is the high enthusiasm and commitment of the staff members we encountered during our visits to the states and our meetings with the *ad hoc* committee of state representatives. This commitment transcends any personal gain that the staff could expect to receive from this program. On the contrary, a number of staff members have contributed in a manner that would bring them to far higher salaries if they were working in private industry. In one instance, the program director is part of the state's civil service and the small size of his staff precludes him from advancing in grades, but he is recognized throughout the state as a major contributor to the state's economic growth.

Nevertheless, the field agents could benefit from further training and guidance. To be successful, a field agent should be trained to

perceive the possible effects of new technologies on industry. He must also be able to present technological information in a form understandable to people in industry. Because problem-solving is a crucial activity within the program, the field agent should be able to identify with the problem and procedures of a given industry or industry groups so that he can be perceived as being "on industry's side." The agent need not have training in a specific technical area to be helpful, but he should be able to familiarize himself quickly with the methods and terminology used in that area. It may often be useful to have some field agents with specialized technical knowledge in given areas, so that problems in those areas can be referred to them.

In addition to having a technical education, therefore, a field agent should:

- Be well versed in the basic economics of business enterprise,
- Be imaginative and capable of readily grasping new concepts,
- Be able to quickly learn a company's research and manufacturing capabilities and its marketing objectives,
- Be capable of assessing the effects of changes on a company and on the social environment,
- Be able to convey new ideas and deal effectively at different levels within the company,
- Be willing to seek and accept responsibility for the problem-solving activities from inception to successful conclusions, and
- Be flexible enough to discard a pet idea when it becomes inappropriate and to look beyond stock answers or procedures for the solution to a problem.

The best way to select new field agents is to find people who have a proven record of success with industrial problem-solving or consulting. Sales or marketing experience, particularly with technical products, would also be desirable. A useful selection procedure might be to have successful field agents interview potential applicants and to rely on the agents' judgments.

Field agents with the general qualifications outlined above will require high salaries, good facilities, and strong support. We have found that successful field agents often receive employment offers from the industries they serve and are lost to the program. Compensation practices, therefore, should recognize the need for higher pay levels and better facilities for field agents. Reduction in program costs could be achieved with fewer field agents who are better trained and capable of assuming more responsibility and authority.

Field agents capable of doing an effective job neither need nor want detailed instruction on how to go about their work. The best way to provide this type of man with useful and constructive criticism while cultivating and supporting his independent thought and action is through seminars, organizational development activities, and group meetings where a full, frank exchange of experience is possible. New personnel might be supplied with a written guide to provide background information. There should be continuing review of cases and failure analysis of activities to give program personnel the opportunity to learn from their mistakes.

Mr. DUDLEY. The Arthur D. Little Co. evaluated specific cases.

Mr. LAFALCE. That is very good.

Mr. DUDLEY. In fact, one of the companies evaluated was a firm in Statesboro, Ga., that bottles condiment items, preserves, and jellies. We redesigned the closure system for their bottle, and then assisted the firm with installing the manufacturing process necessary to implement the design improvement.

Arthur D. Little looked at the long-term economic impact of the work we did at that company and used it to characterize their summary of our work's effects.

Our division worked in the late 1960's and early 1970's under a program called State Technical Services. Have you have ever heard of that program?

Mr. LAFALCE. No.

Mr. DUDLEY. A great deal of the analysis and investigation for the Arthur D. Little study was done there.

Mr. LAFALCE. Do you get much opposition from the private sector, from consulting engineers who say:

Hey, you are doing what we do, only we get paid for it from the private sector, and you are competition for us. For every one you help, there are 100 businesses that need to be helped. You are just helping the select few and we could help them, too. Why should you be in existence and in competition with us?

Mr. DUDLEY. Usually, out in the remote locations where we do almost all our work, no consultants are available. They just are not available. In the Atlanta metropolitan area, you will find consultants.

Mr. LAFALCE. Do you work in Atlanta itself?

Mr. DUDLEY. To a limited degree.

Dr. CLIFTON. Adding to your comments on that point, many of the companies we deal with are so small that they couldn't afford to hire consultants.

Mr. DUDLEY. They probably would accept the proposal, but they would be overwhelmed by the cost. Again, as Dave remarked, they can't afford a failure.

Dr. CLIFTON. Also, we do refer people to consultants in some specialized areas that we don't cover ourselves.

Mr. LAFALCE. Any comments you would like to make about the rather extensive questioning and dialog we had with Mr. Milbergs and Mr. Shallot?

Mr. DUDLEY. I agree with your summation. Small business in the United States is extremely important. MIT did a study in 1979 on the 5.6 million firms in Dun & Bradstreet's data base. According to the MIT research, of the new jobs 66 percent generated in the United States came from businesses employing 20 or fewer people and 80 percent came from firms employing 100 or fewer.

Small firms have flexibility. It surprises me sometimes that I can say to a company, "You need to acquire this piece of equipment," and I will come back and they will have purchased it. These decisions sometimes involve several thousand dollars. These firms can act. I think that this flexibility is the major reason that small firms have succeeded in the past.

I am not sure now that the small business environment is as conducive as it has been in the past. For that reason, our assistance is in greater demand than at any previous time. I never have a prob-

lem of what to do. I always have a backlog of projects requiring my attention.

Something else that interested me was the announcement of the National Productivity Advisory Committee. All the members of that committee are from major corporations; there is not a small business representative in that group. I doubt that they will have the perspective of small firms in mind in the reports or initiatives they put forward.

Mr. LAFALCE. I was really disappointed when the Department of Commerce representative, Mr. Milbergs, did not even use the word "small" once in his written or oral presentation appearing before a small business subcommittee.

Mr. DUDLEY. Georgia is dominated by small firms, small manufacturers that not only serve as vendors for the large companies, but that produce products for their own markets. Because of their ability to make decisions, small firms can respond quickly to problems and changing conditions. Our small manufacturers are a tremendous resource in the State of Georgia.

Mr. LAFALCE. Georgia Tech is where in Georgia?

Dr. CLIFTON. Atlanta.

Mr. DUDLEY. It has 11,000 students, and 23 engineering schools, and operates the largest electrical engineering school, and the largest industrial engineering school in the country.

[The prepared statement of Dr. Clifton and Mr. Dudley follows:]

PREPARED STATEMENT OF DR. DAVID S. CLIFTON, JR., AND SHERMAN L. DUDLEY, GEORGIA PRODUCTIVITY CENTER, GEORGIA INSTITUTE OF TECHNOLOGY

WHAT IS THE GEORGIA PRODUCTIVITY CENTER?

The Georgia Productivity Center (GPC), established by the Georgia General Assembly in 1975, is the nation's first state center dedicated to improvements in business and industrial productivity. The Georgia Institute of Technology, one of the nation's leading engineering institutions, is the Center's home base. Among the more than 200 universities in the U.S. offering engineering degrees, Tech ranks in the top five in level of research activity. Building on Tech's two decades of service to Georgia industry, GPC provides problem-solving services in the following four areas: Innovation, research and development, safety and environmental counseling, and human resources.

HAS GPC BEEN ABLE TO ESTABLISH GOOD RELATIONS WITH GEORGIA FIRMS AND PUT ITS SERVICES TO WORK?

Last fiscal year nearly 2,000 Georgia firms took advantage of GPC's services in the areas of process improvement, energy, savings, quality assurance, management enhancement, occupational safety and health, and environmental assessment.

HOW DOES THE GEORGIA PRODUCTIVITY CENTER WORK?

GPC's staff consists of experienced engineers and management specialists whose backgrounds and expertise cover the broad spectrum of industry groups. These individuals work within a network of 8 field offices in strategically located areas of the state. These offices were created in 1961 and are staffed by full-time engineers, who are supposed by the technical specialists and extensive research resources on the Georgia Tech campus in Atlanta. The field engineers become thoroughly familiar with the manufacturers in thier specific region and learn of their problems, needs, and areas of potential improvement. With support from the staff on the Georgia Tech campus, they work closely with plant personnel to clarify problems and recommend action. Primarily, GPC seeks to help firms help themselves. GCP always works to follow through and maintain contact because many of its projects require a good deal of time to complete in such a way that their positive effects on productivity will be long-term and long-lasting.

WHAT ARE SOME EXAMPLES OF WORK THE GEORGIA PRODUCTIVITY CENTER HAS DONE?

A good example of GPC's work is the fifteen-year relationship it has enjoyed with the Rainbow Manufacturing Company, a manufacturer of irrigation systems in Fitzerald, Georgia. The Productivity Center initially helped the firm with problems in its aluminum foundry, and later analyzed a problem of excessive vibration that was causing bearing failure in a centrifugal pump. The Center is currently assisting the firm in designing an electronic control system to direct the movement of irrigation equipment. Starting out with 12 employees and sales of approximately $1 million, Rainbow has grown to its present level of 135 workers and annual sales of more than $15 million.

In another instance, GPC designed a preventive maintenance management system as a demonstration project in Haralson County because many Georgia counties are struggling with mushrooming repair costs on expensive road maintenance equipment. GPC developed a record-keeping and scheduling system to increase workers' motivation and arranged for equipment operators to get specific preventive maintenance training. Haralson County expects to shave 20% off its $300,000 maintenance and repair budget in the programs' first year. Once the system is fully implemented, it can be modified for counties all over Georgia and elsewhere.

WHAT KINDS OF FIRMS DOES GEORGIA PRODUCTIVITY CENTER ASSIST?

Because most small businesses cannot absorb the cost or incur the risks involved in traditional technology transfer, GPC provides most of its cost-free services to small and medium-sized firms. Many of these firms desire to innovate, but are reluctant to hire private consultants because they have never done so before and cannot afford a single failure in an activity in which failures outnumber successes by something like 10 to 1. These firms often attempt to innovate but have neither the technical staff to follow thorugh internally or the financial resources to absorb failure. Because its productivity assistance is free to the user, GPC's technology transfer service encourages many firms to attempt innovations they need but are heistant to risk on their own.

DOESN'T THIS EMPHASIS ON SMALL FIRMS LIMIT THE GEORGIA PRODUCTIVITY CENTER'S IMPACT?

Over 78 percent of Georgia's manufacturing firms have fewer than 99 employees, and GPC expects small and medium-sized manufacturing to continue to be the backbone of Georgia's economy. This statewide assessment of the importance of small business was confirmed on the national level by a recent study at the Massachusetts Institute of Technology in which researchers analyzed data on 5.6 million firms on file with Dun and Bradstreet. This study determined that between 1969 and 1976, more than 80 percent of the new jobs generated in the U.S. were with businesses with 100 or fewer employees and 66 percent of the new jobs were with firms employing 20 or fewer people.

Expanding small manufacturing businesses is particularly important in rural areas where agricultural workers are routinely displaced by farm mechanization. These new jobs keep people in their home regions, making it unnecessary for them to migrate to urban areas where public assistance might be their only option. Also, helping small businesses expand doesn't tax a community's existing utilities, services, and resources as much as a totally new plant does.

WHAT DOES GEORGIA TECH OFFER AS A BASE FOR THE GEORGIA PRODUCTIVITY CENTER?

As a national leader in technological research with a twenty-year track record of first-rate assistance to Georgia industry, Georgia Tech has demonstrated as full a commitment to increasing industrial productivity as businesses themselves. A U.S. Department of Labor report indicates that technology contributes more to productivity (72 percent) than any other factor. Technological innovators at Georgia Tech cooperate with the Productivity Center field engineers who provide inplant assistance and assure that Georgia firms achieve the level of technological development they require even if they are not large enough to maintain their own technical staffs.

CAN THE SUCCESS OF THE GEORGIA PRODUCTIVITY CENTER BE REPLICATED IN OTHER STATES?

The Georgia Productivity Center's success rests on a carefully established pattern of linkages between three essential components:

Access to and support provided by the broad base of state-of-the-art technical expertise at Georgia Tech;

Field engineers with strong industrial experience who work directly with firms on productivity improvement; and

A technical staff that serves as an intermediary between the technical information and expertise on the Georgia Tech campus and the field engineers seeking to solve specific problems they encounter at the firms they work with.

Any state with a strong technical research base can work to set up a system like this, but it is GPC's experience that unless all three components are included, the program will fail. There is no way to cut corners. Technical experts who publish in scholarly journals will not get their information into firms. Engineers working in firms will very likely not have access to the most innovative productivity improvement methods. One-to-one interaction between a company and a technical specialist with the support of a large research base is the only way GPC has identified to realize true and lasting productivity improvements.

Conferences, technical literature, and the like provide the already established means by which technical specialists in different states can inform each other of their progress. Beyond that point, careful communicative structures with strong links must be created. This process is neither quick, easy, or inexpensive. But it produces results. The Arthur D. Little Company identified a benefit-to-cost ratio of 22.1 for the Georgia Productivity Center. There is no reason why any program established and supported with similar care would not produce equal results, thereby improving the productivity of productivity improvement efforts!

Mr. LAFALCE. Let us turn to Mr. Mitchell Fein, president of Mitchell Fein, Inc.

TESTIMONY OF MITCHELL FEIN, PRESIDENT, MITCHELL FEIN, INC., HILLSDALE, N.J.

Mr. FEIN. I would like to read my statement. I am sure you will have comments and questions on the points and facts that I will state.

Mr. LAFALCE. All right. Your statement is approximately seven pages, so please proceed.

Mr. FEIN. I timed it, and it takes 10½ minutes.

Mr. LAFALCE. We will give you 11.

Mr. FEIN. Mr. Klein said to keep it to 10. I am familiar with the value of time.

I am pleased to appear before this committee to describe how 72 American manufacturing companies, ranging in size from 30 to over 2,000 employees, raised their productivity on the average by 9.4 percent at the end of 12 weeks, and by 22 percent after a year. The details for these statements that I am going to make are contained in a paper you have there which is called "Improved Productivity Through Worker Involvement."

Mr. LAFALCE. That will be included as a part of the record.

[The information referred to above follows:]

IMPROVED PRODUCTIVITY THROUGH WORKER INVOLVEMENT

by

Mitchell Fein

Abstract

The ideas, judgments, and biases on how most effectively to reshape the world of work, together with the issues which deter managers, workers and unions from adopting changes in traditional worker-employer relations, are examined against many successes and failures.

This paper proposes that worker involvement programs which offer only job satisfaction as the prime reward for involvement will be supported by only a small proportion of the work force and tap a fraction of the potential for improvement in the organization. Worker involvement programs which offer financial rewards by sharing productivity improvement with employees through formal productivity sharing plans create high levels of involvement, produce results very quickly, and raise productivity to much higher levels than are attained by nonfinancial reward programs only.

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IMPROVED PRODUCTIVITY THROUGH WORKER INVOLVEMENT

This paper examines the ideas, judgments, and biases on how most effectively to reshape the world of work so that everyone benefits in win-win relationships. The issues which deter managers, workers and unions from adopting changes in traditional worker-employer relations are examined against many successes and failures. Decision makers on all sides need to know what works and what does not, and why.

The factors and conditions at the work place which affect employees' attitudes to their work and especially to increased productivity are described and examined. Much research and writing has been devoted to the subject of worker motivation, yet there is a wide gulf between how workers and managers view the world of work.

The organization psychology school of major theorists such as McGregor, Maslow and Herzberg postulates that involvement by workers in their work in itself is satisfying and rewarding; that though people work for money, the role of money as a motivator to improved work performance is minimal; the major motivation to work is provided by the work itself and other nonfinancial factors.

These concepts were the foundations for the much publicized job enrichment experiments starting with Texas Instruments, AT&T and others, the job restructuring and design efforts through organization development, on through the Quality of Work Life and the more recent Quality Circle programs. All have a common base: The main reward offered to workers for involvement in these programs is the satisfaction of having contributed to improvements in productivity and how work is performed. None offered financial rewards either as an inducement to participate or as a reward for improvements in work and in productivity.

This paper disputes the claim that the work itself is a primary motivator for most workers and supports the proposition that financial incentives, at least for manufacturing plants, is a more powerful means to encourage workers to increase their productivity and to accept managements' productivity goals as congruent with theirs. The work itself is attractive to a minority of the work force. Increased earnings through productivity sharing plans is attractive to all.

This paper proposes that:

> worker involvement programs which offer only job satisfaction as the prime reward for involvement will be supported by only a small proportion of the work force and tap a fraction of the potential for improvement in the organization.

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> worker involvement programs which offer financial rewards by sharing productivity improvement with employees through formal productivity sharing plans create high levels of involvement, produce results very quickly, and raise productivity to much higher levels than are attained by nonfinancial reward programs only.

There are no data on entire plants to show the effect on worker satisfaction and on productivity through the operation of psychological needs rewards programs as against financial rewards. Data are not available simply because no company will sponsor or permit studies to be made which would split a company to operate both programs side by side. The two reward programs can be compared by examining two aspects of results: (1) how long it takes to establish an involvement program, and (2) the extent to which productivity is improved. The reasoning to using these two measures is that a program which is established quickly probably has more worker support than a program which takes longer to get into operation.

Obtaining higher productivity gains compared to lower gains probably indicates that workers in the high gain plants are more involved in helping to raise productivity since productivity gain is measured as the increase obtained over management's best efforts in the base period before the program starts. These two indicators may be challenged as oversimplified and not reliable, but as will be shown, the differences in results obtained between the psychological needs rewards and the financial rewards are so great that there can be no question that the differences are significant.

Encouraging worker involvement

Much of the literature favoring employee involvement in raising productivity and improving workplace conditions frightens many managers who fantasize that employees will take over the shop, get on the Board of Directors and order managers around. The leadership of the AFL-CIO and the major unions in the United States have on numerous occasions stated that they are unquivocally against a partnership with management in operating companies; they prefer the adversary relations of collective bargaining.

Despite strong denials from union leaders that they want to share the board rooms with management, apprehension continues at top management levels that any dilution of management's traditional rights is a step closer to worker control of the shop. Feeding management's fears are the vaguely defined terms used in management and behavioral science literature in this country which create misconceptions concerning worker involvement efforts. The term "participation" is applied to a wide range of activities in which workers voluntarily become involved with management to solve problems, and "participative management" is used to describe the attitudes of managers who favor the involvement process.

Participation does not adequately describe the true relationship between nonmanagement employees and management in these voluntary efforts. Participation implies that those involved have a share of responsibility for results, which they do not have. Involvement without accountability is not participation, but consultation. That is what really occurs when employees are encouraged to suggest improvements; management may accept or reject employees' ideas, because only management has authority to make decisions.

"Involved in decisions" is another term used vaguely in the literature and this, too, is misleading. Workers can make suggestions and are consulted; they may influence decisions, but they are not involved in decision making in the sense the term is used in managerial practice. Using these terms loosely can harm cooperative efforts in two critical areas:

- Managers may assume the literal meaning of "participation" and "involved in decision making" and reject cooperative efforts, apprehensive that employees will take over the shop.
- Workers may be disappointed when they find they have less influence than they were led to believe they would have.

The term "participative managing" should be replaced by the more appropriate and descriptive "consultative managing."

Consultative managing encourages worker involvement in day to day operations, in questioning how work is performed and suggesting changes. This significant change from traditional managing affects many other business policies. For consultative managing to be successful, it must be accepted by top management, believed in, and followed down the line by supervisors.

Consultative managing does not require management to give up any of its rights to manage; management still has the last word in all decisions. Managers give up only the right not to listen, and take on an obligation to consider employees' proposals. Most important, managers' actions and attitudes must show they mean what they say.

Encouraging workers to become concerned with improvements and aid in raising productivity alters their perceptions of their roles in the company. Management cannot tell workers to become half involved, to think only about work and to ignore everything else. When workers can question how an operation is performed, they may question other things. Tough traditional managers may not take kindly to questioning from below, but it is necessary for consultative managing. Democratizing the work place will frustrate many managers who are accustomed to making decisions and giving few explanations for their actions. Having to give reasons to worker groups for not making changes may be time consuming, but that may be part of the price for gaining worker support.

Psychological needs reward programs

Psychological needs reward programs are based on several major premises:

- The work itself is a powerful motivator to involve workers in their work.
- Work tasks in factories have been so simplified that workers' desires to work are turned off. The remedy proposed is that skills and judgments should be added to denuded jobs; enriched jobs are more desired by workers.
- The mechanical nature of work and the low challenge of the work place has created worker dissatisfaction which reduces worker productivity. Restructuring jobs with greater responsibility and judgments will remedy the disenchantment process and result in more effective work performance.

The role of financial incentives as a reward for improved performance is minimized by supporters of this school, who propose that psychological and social needs are very important to workers and vital to their well-being. Behavioral science writings highlight studies which demonstrate that workers value money and job security lower than opportunities for work involvement activities.

Much of the support for the interesting work concept is based on the 1970 SURVEY OF WORKING CONDITIONS prepared by the Survey Research Center (SRC) of the University of Michigan, widely cited as the authority that interesting work is preferred by workers over pay.1/ The study found that of the five work features rated most important by workers, only one had to do with tangible or economic benefits and that one, good pay, was ranked number five.

An analysis by Fein of the SRC data found that the SRC researchers had erroneously averaged all the data for executives, professionals, technicals, clericals, sales service, factory workers, truck drivers and farm workers, and called the average a "composite worker." When the data were analyzed by occupation, good pay and job security moved up and interesting work dropped for factory workers; professionals and managers may place a higher priority on interesting work.2/

A study by Edwin A. Locke, et al, found that money is a more powerful motivator than is generally believed:

> Our findings may surprise or even shock many social scientists. For the last several decades ideological bias has led many of them to deny the efficacy of money as a motivator and to emphasize the potency of participation. The results of research to date indicate that the opposite viewpoint would have been more accurate.3/

The notion that a lack of interesting work causes dissatisfaction among workers and so reduces their will to work is not solidly supported by research and data. A study of 300 research studies

on the relation between job satisfaction and motivation by a New York University team, supported by the National Science Foundation (NSF/NYU), headed by Katzell and Yankelovich, of which this author was a member, found that:

> .....if there is any one fact that stands out clearly from the massive accumulation of data - the hundreds of studies encompassed in this report - it is that worker job satisfaction and productivity do not necessarily follow parallel paths. This does not mean that the two objectives are incompatible, for there is evidence that it may be possible to achieve them together. Nor does it mean that the two goals are totally independent of one another. Under certain conditions, improving productivity will enhance worker satisfaction and improvements in job satisfaction will contribute to productivity. What it does mean is that there is no automatic and invariant relationship between the two.
>
> Indeed, the two objectives are so loosely coupled, there are so many intervening links between them, and the relationship is so indirect, that efforts which aim primarily at improving worker satisfaction on the assumption that productivity will thereby automatically increase are more likely than not to leave productivity unchanged, or at best to improve it marginally, and may even cause it to decline.4/

Four combinations of satisfaction/motivation are possible:

- A satisfied worker may be highly or weakly motivated.
- A dissatisfied worker may be highly or weakly motivated.

The data do not show a negative or a positive relationship, rather no relationship. The NSF/NYU study found that though common sense and logic suggest that improved job satisfaction leads to raised motivation, workers do not necessarily react that way. A satisfied worker may just be a satisfied worker, not any more motivated to produce than before.

Studies and data I have examined over the years point to two main groups at work. About 15% of the work force are active involved people who identify with their work; interesting and judgment-laden work is important to them. The other 85% of the work force come to work to eat; the nature of their work is not critical to them; they find their involvement and gratification outside the work place. The 15% achievers get into the skilled jobs. The 85% nonachievers take on jobs they prefer, but interesting work and fulfillment from their job is not necessary for their well-being. Obviously there are gray areas between the groups.5/

Real life experience in plants bears out this 15/85 concept of workers' desires. A study by Simons and Orife reported that:

> In 51 of the 71 pairs of jobs, employees transferred to jobs with increased pay; only 4 moved to lower pay. The majority of the higher-paid jobs to which workers moved

> were more enriched, but when the job shift did not provide a pay increase, no preference was shown for the more enriched job. No statistically significant preference for less routine (more enlarged) jobs was shown either with or without increased pay. Required physical effort proved not to be a significant factor.
>
> The assumption that job enrichment and/or enlargement is sought and desired by employees has become widespread in recent years. This is despite the fact that empirical studies of what workers want in their jobs have been limited, have often been based on questionable methodology, and have at times given conflicting results.6/

Job bidding records in companies provide ample data of which employees desire to change their jobs. Invariably the most senior employees, who normally have first claim to job openings, are not those most frequently bidding. Significantly, few employees shift to higher skilled jobs without a pay increase. Data on worker job preferences show that transfers to higher rated jobs reflect individual worker desires. Everyone wants more money, but as jobs become more demanding, fewer employees aspire to these jobs.

The various reports of experiments with nonfinancial psychological needs programs provide sparse data, if any, on the productivity gains achieved through the programs. Results attained in creating better labor relations, improved job satisfaction, reduced spoilage, fewer grievances, and so on, are also sketchy and difficult to reduce to hard data. A key indicator of the accomplishments can be inferred from the fact that these programs have been terminated by management with no record of workers in these plants have objected to their discontinuance.

The arguments in favor of psychological needs reward programs do not stand up when all the experimental data and cases are examined. Involvement in the work is a need of the minority of the work force who benefit from it. A large majority of workers have other needs and wants which come before work involvement. They, too, may find satisfaction from involvement in their jobs, but it is of a lower order than for the achievers.

The inequity of nonfinancial reward programs

Practically no QWL, Quality Circle or behavioral science-supported worker involvement programs provide financial gains to groups of workers or entire plants when operations are improved. Their only reward is a feeling of satisfaction from having done a good job and helped the company.

Not rewarding workers for improvements they create is questioned on two grounds: equity and fairness; both are linked in workers' minds. Many companies that try hard for years to develop credibility with their employees may find that workers resent performing work for which they are not compensated.

Management violates universally accepted principles for establishing equitable pay rates by encouraging employees to work at higher skill levels without commensurate extra compensation. Pay scales in the private and public sector are set to reflect the skill and effort needs of the job. Many companies determine job rates through formal job evaluation plans. The procedure always followed is to prepare a job description delineating the principal requirements of a job and then evaluate the job against a point evaluation plan. Production jobs never require employees to use judgment and initiative to improve the way work is performed and to reduce costs; these tasks are the responsibility of technicians and engineers, who are properly paid to do such work. When higher level tasks are added to a job, it is reevaluated and a new job rate is set.

When workers are encouraged to use higher skills to innovate work improvements they should receive extra compensation for their efforts. If workers feel good because they did a good job, they will feel better with extra pay, which is an excellent way for management to thank these employees who did more than was expected of them.

As their efforts reduce operating costs and workers do not share, management's credibility and good faith are questioned. It is one thing for workers to cooperate and work hard to prevent a plant from closing; everyone gains as the plant and jobs are saved. It is quite another for a company not in dire straits to pocket the gains from cooperative efforts.

Rewarding improved performance

Managers wishing to improve productivity with money as a motivator will find support in the findings of a behavioral science study which agrees that money can be a prime way to increase employee motivation. The NSF/NYU study team developed six critical ingredients of effective systems to raise job satisfaction and worker motivation, headed by:

> Financial compensation of workers must be linked to their performance and to productivity gains.7/

The NSF/NYU study found that when workers' pay is linked to their performance, the motivation to work is raised, productivity is higher, and the workers are more likely to be satisfied with their work.

A study by Fein of over 400 plants in the United States found that when these plants instituted work measurement, productivity rose an average of 14.6%. When plants instituted traditional wage incentives where previously there was only work measurement, productivity rose an added 42.9%. The average increase from no measurement to incentives was 63.8%.8/

Most managers believe that pay tied to productivity will motivate to higher performance. From two-thirds to three-quarters of all the sales forces in the United States are on incentives.9/ Approximately 89% of manufacturing companies have executive bonus plans; the median bonus for the three top executives averages 48% of their base pay.10/ A study of executive compensation of 1100 companies listed on the New York Stock Exchange found that companies which had formal incentive plans for their executives earned on the average 43.6% more pretax profit than did the nonincentive companies.11/

By any measure, pay tied to productivity is the most powerful motivator to improve work performance. Strangely, it seems as if proponents of nonfinancial reward systems are saying that money is unwholesome and debasing. Compensation practices in the United States are based on the principle of equal pay for equal work, in which workers expect and receive higher pay as the skill and demand characteristics of their jobs increase. Japanese workers, who are held up as models for American workers, work under an entirely different system. Primary pay differentials are based on seniority and education with education assumed to reflect job skills, while seniority is related to job performance.

Within the American culture workers strive for increased earnings and benefits. Executives of large American corporations with salaries around $350,000 aspire to bonuses which bring their total pay to over $1 million a year. When top managers seek more, why are workers, who may barely eke out a living wage, expected to place their work above pay and job security?

The work itself serves as a motivator to some workers and its importance should not be overlooked. Money has been shown to have universal appeal; pay by performance definitely encourages higher performance.

The rationale of productivity sharing

A productivity sharing plan divides productivity gains between employees and the company when productivity exceeds the level of the base period. A prime objective of productivity sharing is to create conditions under which workers and management benefit by moving on parallel paths to a common goal: more units of product made in fewer man hours of work; only finished good units are counted. The entire plant or company is grouped.

The rationale for traditional wage incentives stems directly from traditional managing practices; it is rooted in the adversary relations environment of the work place. Time standards under traditional managing, whether for measured day work or for incentives, are probably the greatest single cause of worker grievances. The we-they relations on the plant floor are sharpened by traditional incentives.

Productivity sharing is not an incentive plan; it is a philosophy of managing that encourages employees to become involved in productivity improvement. Productivity sharing creates a work environment in which employees see improved productivity as beneficial to them. Under the philosophy of productivity sharing, worker productivity goals and management goals become congruent.

Under productivity sharing, measurement standards are established as the average of a past base period for an entire product. Using the past base eliminates disputes on the plant floor over loosening operation time standards. A major difference between traditional incentives and productivity sharing is that under incentives, individual workers are motivated only to make more money; they have no interest in raising productivity or in management's productivity goals. Under productivity sharing, workers may still be primarily motivated to make more money, but since productivity sharing is based on achieving overall improvement in productivity, more money is earned only by raising productivity. Employee interests expand to the plant when all employees are rewarded as a group for their gains. Counting output only as finished units ready for shipment, and rewarding all workers for productivity gains over a base period, focuses their attention on the need to reduce labor input and increase product output.

As workers' interests shift toward management's, the rationale for traditional managing fades. When workers become concerned with final outcomes, they are also more interested in how operations proceed throughout the plant; they become attentive to production impediments that occur around them which in the past they ignored or even encouraged. Since productivity gains are shared, whether innovated by workers or by management, it is conceivable that industrial engineers, who are now disparaged by workers, will instead be welcomed because workers will gain from engineers' improvement efforts. That would indeed signal a significant change in the attitude of workers and managers toward each other's interests and needs.

Productivity sharing plans in use

Three productivity sharing plans are used in this country: the Scanlon Plan since about 1936, the Rucker® Plan since World War II, and the Improshare® Plan since 1974. All are company-wide sharing plans with significantly different productivity measurement systems.

The Scanlon Plan

The Scanlon Plan, developed by Joe Scanlon, then research director of the Steelworkers Union, is the most widely known plan in this country. The term "Scanlon Plan" is often used generically, referring in general to productivity sharing. After Scanlon's death in 1956, several associates carried on his work; Frederick Lesieur and Carl Frost are the most prominent.

The Scanlon Plan measures productivity improvement by a change in the computed ratio of total payroll dollars divided by the total dollar sales value of production. Most Scanlon Plans distribute 75% of the gains to employees and 25% to the company, though the percent can be changed. Twenty-five percent of the monthly gains are placed into a pool to absorb loss months; at the end of the year the entire pool is distributed. Other plan details relating to how and when sharing gains are paid, the highly structured suggestion plans and labor management committees do not significantly differentiate the plan from others.

Moore and Ross present considerable operating details and different ways to measure productivity changes to overcome the single ratio measure.12/ Frost, Wakely and Ruh describe Scanlon Plans in operation.13/ Both books are excellent as source materials and contain broad bibliographies of published materials on Scanlon Plans.

The Rucker Plan

The Rucker Plan was developed by Allan W. Rucker of the Eddy-Rucker-Nickels Company in Cambridge, Mass., in the late 1940's. Measuring productivity change as a change in the ratio between dollar payroll and dollar value added provides a more reliable measure than the Scanlon measure of payroll dollars per dollar sales value because, under value added, all purchased materials are excluded. The calculations are similar to Scanlon, except that instead of sales dollars, the figures used are sales less all purchased materials. Productivity measurement under Rucker with a single ratio presents the same problems as under Scanlon. Several papers describe details of the Rucker measurement system.14,15/

Improshare

Improshare is derived from "improved productivity through sharing." The plan was developed by Mitchell Fein and was first used in 1974; parts of the plan were used for over 20 years. Improshare productivity measurements use traditional work measurement standards and practices modified to a selected base period. Productivity measurement with Improshare is considerably different from Scanlon or Rucker. Productivity gains are shared 50/50 between employees and company. Improshare details are contained in "IMPROSHARE®: An Alternative to Traditional Managing."16/

The GAO study of productivity sharing programs

The General Accounting Office conducted a study of productivity sharing programs 17/ to determine (1) how productivity sharing plans operate and what benefits are obtained, and (2) what long term increases in productivity can be realized through productivity sharing. The report estimates that about 1000 productivity sharing plans are in use. The GAO researchers solicited 78 firms and interviewed the managers of 54 to determine their experiences with productivity sharing and other incentive plans. Thirty-six of the firms interviewed had productivity sharing plans of which 17 were Scanlon, 8 were Rucker, 11 were Improshare, and 2 were other. Of the 9 firms interviewed which did not have productivity sharing plans, 5 had individual or group incentives based on engineered standards, 5 had profit sharing, 4 had Quality of Work Life programs, and 2 were "other"; the total adds to 16 because several of the firms had more than one type of plan. The size of the firms contacted ranged from a small company with less than 100 employees to one with over 100,000.

The GAO report briefly describes traditional individual and group incentives, suggestions systems and profit sharing. The prominent features of Scanlon, Rucker and Improshare plans are described, including how productivity is calculated.

The GAO reports that:

> Among the 24 firms providing financial data, those with a productivity sharing plan in effect the longest showed the best performance. Firms that had plans in operation over 5 years averaged almost 29 percent savings in work force cost for the most recent 5-year period, with individual firms' average savings ranging from 13.5 to 77.4 percent. Those firms with plans in operation less than 5 years averaged savings of 8.5 percent. To cite some specific examples: A company with 360 employees reported an average savings in cost of 15.5% over a 5 year period. Another company employing 2000 saved an average of 24% over 5 years, ranging from 20-35% a year. A company of 215 employees averaged 14% savings over 5 years, ranging from 11-18% per year.18/

The GAO cites the nonmonetary benefits of productivity sharing programs: Improved labor relations were reported by 80.6% of the companies, 47.2% reported fewer grievances, 36.1% had less absenteeism, 36.1% had reduced turnover, and 47.2% reported other benefits.

> The vast majority of firms expressed satisfaction with their productivity sharing plans and believed that the current benefits to the firm from their plans warranted their continuation. Officials at 22 firms said that the benefits originally anticipated were realized.....For the most part, firms.....believed that their productivity sharing plan gave them a competitive advantage in marketing their products or services.19/

The rapid start of an IMPROSHARE© Plan

Reports from nonfinancial worker involvement programs show that it takes from a year and half to three years to establish a program which will encourage widespread involvement of workers to improve productivity and labor relations.

The rapid start of an Improshare Plan in the first 12 weeks creates substantial productivity improvement which usually puzzles people who have not been involved in productivity sharing plan activities. The reason for the short starting time is illustrated by a discussion that took place in a meeting called by management of a highly mechanized machine shop to discuss introduction of an Improshare Plan, at which were present operating managers and union committee representatives.

In response to a question posed by the plant manager as to how long it would take for an Iproshare program to start operating, I turned to a union steward from one of the large machine departments and asked him how long it would take for the workers in his department to "rev it up." The response was "15 minutes." This was not a flippant remark, but a considered statement by a knowledgeable worker of how long it would take him to turn up his production - if he wanted to.

When workers want to make suggestions to increase productivity and to increase their own output, all they have to do is do it. It does not require a one and a half to three year program to convince workers that increased productivity under a productivity sharing plan benefits them financial and nonfinancially. When workers realize the financial benefits the plan can provide, and the opportunities open if they wish to become involved, they get into the spirit of the plan. In times of keen competition, helping the company to reduce costs will save jobs, which workers readily recognize. Turning on the 85 percenters who come to work to eat permits the 15% achievers to get involved in work improvements to their hearts' content. The magic ingredient that makes productivity sharing work is financial reward, reinforced as increasing numbers of workers join in the efforts.

Results obtained by IMPROSHARE® companies

The data in Table 1 show the change in productivity in 72 companies after Improshare was established. No hard data is available on employee attitudes before, during and after the installation of an Improshare Plan simply because attitude studies were not made.

Improved results

Discussions with employees, union representatives and managers at the companies showed decided improvements in employee-company relations. Practically all companies reported reduced scrap and spoilage; some quite substantial. Waiting for work and equipment downtime, which cause considerable productivity loss, was significantly reduced. Surprisingly, equipment downtime, which is a responsibility of maintenance mechanics, was often reduced by machine operator ingenuity and diligence.

A prime measure of the effectiveness of an employee involvement program and the degree of employee participation is reflected in the increase in productivity achieved after the program starts. Manufacturing plant productivity is usually on a plateau and fairly flat before the start. The rise that occurs after the start must be attributed to the efforts and cooperation of the employees.

The productivity improvement obtained by 72 companies operating with Improshare since 1974 is shown in Table 1. As of February 10, 1982, 57 plans were operating; five plans were discontinued because the plans did not work; ten plans were discontinued for other reasons: three plants were closed, one plant is being rebuilt and the plan will restart, the business volume in three plants was drastically reduced, two plans were discontinued because of labor difficulties, one plan was suspended and will restart after major production changes have been made.

Thirty-eight of the companies are nonunion and thirty-four are represented by 18 different international unions. The companies range from heavy machinery manufacturing, steel fabrication, foundries, automotive and truck parts, electrical goods, appliances and consumer products, chemicals, wood and upholstered furniture, plastics, lumber and wood products, textiles and

Table 1: **PRODUCTIVITY IMPROVEMENT OBTAINED IN IMPROSHARE® COMPANIES**

Company	Manufacturing	Total Empl	Union	Year estab	% Gain (1) Start	% Gain (1) After 1 yr	Still oper(2)	Prod team
1	metal stampings	75	IUE	1974	12	32	yes	no
2	automotive parts	200	AIW	1976	22	70	yes	yes
3	steel fabrication	375	Teamsters	1980	8	8	yes	yes
4	steel products	500	IAM	1978	11	40	yes	yes
5	mobile trucks	100		1980	6	11	yes	no
6	consumer plastics	125		1978	23	65	yes	no
7	pleasure boats	125		1978	23	42	yes	no
8	outdoor products	350		1979	20	32	yes	no
9	machine shop	300	UK	1977	8	15	NV	yes
10	metal stampings	150		1979	7	18	yes	yes
11	machine shop	85		1978	13	36	yes	yes
12	metal treating	40		1978	8	16	yes	yes
13	automotive	1550	Rubber	1980	3	8	yes	yes
14	electrical products	800		1981	8	16	yes	yes
15	photocopy products	500		1980	9	15	yes	yes
16	heavy machinery	1600	IUE	1979	12	52	yes	yes
17	foundry	275	Moulders	1979	11	52	sus	yes
18	auto parts	750	UAW	1979	15	32	yes	yes
19	trucks	250		1976	13	32	yes	yes
20	automotive	200		1978	7	16	NPC	yes
21	automotive	800	UAW	1980	3	8	yes	yes
22	electrical	250	UAW	1980	3	6	yes	yes
23	consumer	35		1979	10	30	yes	yes
24	consumer	120		1981	7	(3)	yes	yes
25	industrial	125		1979	8	42	NPR	yes
26	chemical	675	OCAW	1980	9	16	yes	yes
27	chemical	650		1980	6	12	yes	yes
28	appliances	400	IUE	1979	20	32	NPC	yes
29	electrical	75		1981	5	10	yes	yes
30	chemicals	375		1979	3	10	NV	no
31	paper	150	Paper Wkrs	1978	8	44	yes	yes
32	paper	1000	USW	1980	2	3	NL	no
33	chemical	450		1980	9	15	NV	yes
34	lumber	40	Woodwkrs	1980	10	18	yes	yes
35	clay products	65	USW	1981	30	30	yes	yes
36	lumber products	85	Woodwkrs	1981	24	34	yes	yes
37	concrete	20		1976	8	22	yes	no
38	plastics	250		1981	6	18	yes	yes
39	steel wire	250	USW	1981	11	20	yes	yes
40	machine shop	125		1981	8	26	yes	yes
41	machine shop	250		1981	9	16	yes	yes
42	sheet metal	50		1979	8	22	yes	yes
43	wood products	175		1979	4	22	yes	yes
44	furniture	300		1977	8	19	yes	no
45	upholstered furn.	200		1979	11	15	yes	no

Table 1 (cont) PRODUCTIVITY IMPROVEMENT OBTAINED IN IMPROSHARE® COMPANIES

Company	Manufacturing	Total Empl	Union	Year estab	% Gain (1) Start	% Gain After 1 yr	Still oper(2)	Prod team
46	furniture	35	Brick Clay	1978	12	70	yes	yes
47	upholstered furn.	100	Furn Wkrs	1979	12	16	yes	no
48	upholstered furn.	125		1979	9	20	yes	no
49	wood furniture	450		1981	16	31	yes	no
50	leather	55	AMC	1976	12	25	yes	yes
51	fabric	100	Textile	1980	12	44	yes	yes
52	warehouse	50	Textile	1980	18	75	yes	yes
53	consumer	65		1977	18	35	yes	yes
54	consumer	250		1978	12	18	yes	yes
55	electrical	65		1978	35	55	yes	yes
56	metal stampings	90		1978	16	35	yes	yes
57	metal products	35		1978	10	25	yes	yes
58	metal furniture	550	Teamsters	1981	10	55(4)	yes	yes
59	chemical	300	Teamsters	1979	0	0	no	no
60	automotive parts	110	Independ.	1980	11	28	yes	no
61	consumer	140		1978	12	22	yes	yes
62	trucking	75		1975	5	0	no	no
63	consumer	550	IUE	1979	6	8	no	no
64	fabric	15	UAW	1981	15	(3)	yes	no
65	machine shop	65	UE	1981	9	(3)	yes	yes
66	electrical	155		1981	21	(3)	yes	yes
67	electrical	160	IUE	1981	19	(3)	yes	yes
68	oil equipment	600		1977	6	0	NL	no
69	machine shop	110	Teamsters	1980	8	10	yes	yes
70	sheet metal	85	Teamsters	1978	30	58	NPC	yes
71	plastics	220	Teamsters	1977	11	8	no	no
72	construction	200		1978	7	0	no	no

Notes:

	Total plants
(1) first 6 weeks	
(2) as of 2/10/82	
(3) less than one year	5
(4) expected year end	1

Plans not operating:

Sus	suspended, will restart	1
N	No, discontinued	5
NPC	No, plant closed	3
NPR	No, plant rebuilt	1
NV	No, volume reduced	3
NL	No, labor problems	2

Summary increase percent

	12 wks	1 yr
Average all companies	9.4	22.2
Average companies continued plan	10.3	24.4

fabric, rubber, oil equipment, construction, transportation, and warehousing. The companies represent a broad cross section of American industry with the exception of primary steel and non-ferrous production. Three plants are in Canada, one in the UK and the rest in the United States, fairly spread around the country. A total of 19,860 employees work in the 72 companies.

Early Improshare Plans up to about 1980 usually covered only hourly employees; occasionally plant supervisors and some plant salaried were included. After 1980 almost all companies, union and nonunion, included hourly and salaried up to managers, excluding only those covered by a management bonus plan. The reasoning is that productivity improvement should be a company-wide activity, with no we-they distinctions.

Table 1 shows the percent productivity gains achieved by each plant in the first 12 weeks of the plan's operation and then after a year. The weighted average increase after 12 weeks for all plants, including plans that were discontinued, was 9.4%. The average increase for all companies after one year was 22.2%. Eliminating companies that discontinued plans increases the first 12 weeks improvement to 10.3% and the yearly figure to 24.4%.

A distribution of productivity improvement percent is shown in Table 2, grouping by five percentage points. Most of the first 12 weeks' gains ranged between 5% to 15%, with a mean of 10.3%. The distribution of one year gains concentrated between 15% to 20%, with a larger number of plants skewed to the higher gain groupings, also reflecting the mean of 24.4%.

Table 2: **PRODUCTIVITY GAINS BY PLANTS**

	Percent gains by plants														
	.01-4.9	5.0-9.9	10.0-14.9	15.0-19.9	20.0-24.9	25.0-29.9	30.0-34.9	35.0-39.9	40.0-44.9	45.0-49.9	50.0-54.9	55.0-59.9	60.0-64.9	65.0-69.9	Mean
0															
end of 12 weeks															
1	7	27	20	7	6	0	2	1	1						
Total plants: 72															
end of first year															
4	1	6	3	15	5	5	8	3	6		2	3		1	3
Total plants 67															
less than 1 yr 5															
72															

Statistical data hides some outstanding gains made by some of the top plants:

- A highly mechanized brick plant raised productivity by 30% in three weeks; savings in fuel for the kilns exceeded labor cost savings. The Steelworkers in the plant cooperated.

- A plywood plant raised productivity by 24% in four weeks, by 34% in 12 weeks, and averaged 34% at the end of a year. Output of this plant now exceeds the productivity of other similar plants in this large company. The Woodworkers Union wholly supported the program.

The financial benefits to employees and company can be seen from the following calculations. Since an Improshare Plan shares productivity gains 50/50 between employees and the company, the gain to both is the same. Using an hourly wage rate of $7.00 as an example, a 1% increase in productivity is worth $70 per year, per employee. The mathematics are: $7.00 x .005 (½ of 1%) x 2000 hrs per year). An increase of 10.3%, when shared, equals 5.15%. At this level, an employee's hourly earnings are increased by $.36, equal to $721 for the year. With a 24.4% increase, productivity sharing to the employee is worth 12.2%, equal to $.85 per hour and $1708 for the year. The savings for the company equals the total savings for all employees. Assuming a plant of 500 employees, at the 10.3% level the increased productivity will save $360,500; at 24.4% the company saves $854,000. Since employees are guaranteed not to make less than their regular earnings no one can lose under the plan.

Poor results and failures with productivity sharing

There are no data showing clearly why some productivity sharing plans produced meager results or were discontinued. Analysing plans that work well does not clearly show which factors contributed to the good results. In reviewing the plans that do poorly, it becomes clear that management's attitude toward worker involvement has a greater effect on results than any other factor, including the initial attitudes of the employees.

It would seem that managers anxious to improve their competitive position and their profits, who know the results that have been obtained by productivity sharing plans, would embrace this approach and proceed to bank the savings. It does not work that way; managers operating their companies for many years in a particular fashion often find it difficult to adjust to changes. Productivity sharing is not like piece work, under which a money hungry worker can work hard at his own job, caring little for those around him. Productivity sharing is a way of life, a way of people working with other people; it recognizes that people are individuals with different needs and desires in life and at their work. A tradition-steeped manager may have trouble in adjusting to working in this people oriented system.

Table 1 shows that all five plants that discontinued Improshare had no productivity teams; three were union, two were nonunion. The two that discontinued their plans because of labor problems also had no teams; one was union and one was nonunion. Lacking clear data, it seems logical that managers in these five plants probably also had poor labor relations. From my contacts with the plants, I know there was low credibility and trust between management and employees in these plants. Managers who lack confidence in the capabilities of their work force and pay lip service to the involvement process, are perceived as not sincere by the workers, who then work as usual and remain uninvolved.

Productivity teams

Labor management committees (LMC), Quality of Work Life Programs (QWL), Quality Circles (QC) and Productivity Teams (PT), all have common goals, yet there are fine differences which depend more on what is meant in a given plant than on definitions of the terms.

Productivity teams afford management and the workers an excellent means for communication, especially important during depressed business conditions. In a number of plants, when workers were shown the economics of costing and how bid proposals are developed and the effect even small cost reductions can have on a company's ability to obtain orders, workers became more conscious of the need for cost reduction. Showing workers where customer orders stand, the backlog of open orders, and the problems and decisions facing management in determining how to operate a plant gives workers an understanding of management priorities. Open two way discussions remind managers that workers also have serious personal problems that need to be considered and production problems at their workplace which affect productivity. Open communication is one of the most important contributions made by productivity teams.

The concepts of LMC, QWL, QC, and PT are different in some respects and are similar in others. The major difference is whether the teams operate under nonfinancial programs or share in the productivity gains they produce. There is nothing about any of the team structures or methods of operation that prescribes whether or not employees should share in the gains; that is a management decision. The prime point of this paper is that when teams share in productivity gains, their actions, efforts and outlook are substantially different from when they do not share; superior results are attained.

Productivity Teams without rewards

In examining the workings of nonfinancial reward labor-management committees, starting with World War II and on, I found that these were not as effective in raising productivity as some writers reported, especially for periods beyond several years. Committees to solve crises have been successful as, for example, the LMC set up in Jamestown, New York, under Stanley Lundine, to create stable labor relations in the area. Similarly successful were the efforts by the union and management to save the plant and jobs at the Tarrytown General Motors plant. Such joint efforts can have

long lasting effects. A classic joint effort was the mechanization and modernizing agreement between the Longshoremen's and Warehousemen's Union under Harry R. Bridges with the Pacific Maritime Association in 1961, which has stood the test of time.

In the absence of clear data on why productivity teams are more effective in raising productivity with financial reward plans than without them, I can only offer my opinion, which is simply that when workers are given a stake in the outcome, and they stand to gain materially through productivity improvement, they will operate at higher levels, cooperate more with management, and do things they would not consider doing in the absence of the rewards.

Productivity Teams under IMPROSHARE®

Of the 72 plants in Table 1, 51 had some form of worker involvement ranging from highly structured labor-management committees with steering and departmental committees, on through weak arrangements with informal meetings at irregular intervals.

Hard data are not available by plant to show the extent to which formal productivity teams increased productivity over the levels attained in plants where worker involvement was weak or nonexistent. Since I was personally involved in almost all the plants and am familiar with what transpired in all plants, I can report that productivity team activities definitely help to improve productivity, if only by creating and spreading receptive and supportive attitudes among the workers. Suggestions and improvements made by team members, together with technicians and engineers, are, of course, what team involvement is all about. Active teams goad managers to operate more effectively. The reinforcement process becomes contagious, success encourages greater activities. The most effective teams become important adjuncts to the efforts of the company's technicians, specialists and engineers.

The forerunner of Quality Circles

An entirely different approach was developed in the early 1930's by Allan H. Mogensen, Lillian Gilbreth, David B. Porter and Erwin H. Schell, who suggested that workers should be involved in raising productivity by encouraging their participation in work improvement efforts. Their concepts, formalized in 1937 as Work Simplification, proposed training workers in how to make improvements using industrial engineering techniques and to work as teams in diagnosing and solving problems. The story of Mogensen and his associates is contained in "An Amazing Oversight, Total Participation for Productivity."20/ These far-sighted, involvement minded engineers were the pioneers of what later became known as QC Circles, as practiced in this country.

A Work Simplification program sought to train workers and supervisors in the principles of motion economy and how to make improvements in work methods, flow, planning, and other essential aspects of work. The concept was not opposed by workers in shops or by unions in the 1930's; it just did not catch on. During World War II I produced a training manual on Work Simplification principles

for labor-management committees. The manual, PRODUCING FOR VICTORY, was widely circulated by unions and companies.21/ My recollection is that it did not do much to raise productivity.

We now know that the major reason Work Simplification was not widely accepted and used was that workers did not benefit financially from the gains that were made.

Productivity sharing works

Whether something works or not is often more important to a pragmatic manager or union official than why it works. Behavioral scientists are not so easily satisfied; they want to dissect the social forces at work and assign numeric values to their findings. Since all such evaluations are subjective and there is no way to assert with assurance that the numeric values assigned to factors and degrees in a matrix are valid, the values only show the author's opinion.

Disentangling each of the many factors which influence the attitudes of workers and managers, even in a small plant, is extremely complex if at all possible. Frost, Wakely and Ruh discuss the difficulty of dissecting a plan: "....the Scanlon Plan is a complex system of interdependent elements, rather than a single, unidimensional variable. The effectiveness of the Plan is, therefore, very likely beyond simple proof or disproof."22/

We have ample evidence from company figures, discussions at conferences, and personal reports of people who have visited and talked with workers and managers at productivity sharing plants, that attitudes on both sides change, often dramatically. Concern for each other's welfare increases. Workers definitely want to know more about company problems and help to solve them. While psychologists may have difficulty in drawing proofs from their data, managers and workers know productivity sharing promotes improvements they can readily see and which benefit everyone.

In the face of these glowing reports, one may wonder why there are not many more companies working with productivity sharing plans. My answer lies in a simple story: I visit about 100 different companies a year. Each time I return from a trip my wife asks me how the trip went. I invariably give the same response: "I met some wonderful people." When she recently said, "You always say that," I suddenly realized that only people-oriented people will even consider sharing productivity gains with workers. A tough traditional boss prefers to rely on traditional managing.

Improshare is not an incentive plan in the conventional sense, though it shares productivity gains with employees. It is a philosophy of managing which is significantly different from the traditional way in which management views productivity improvement as a unilateral responsibility. In sharing productivity gains, employees accept management's productivity goals. The we-they adversary relationship changes so both gain together as they cooperate to produce more product or services in fewer man hours. Productivity impediments and losses affect both.

Productivity sharing is a way of life. It is an alternative to traditional managing. No claim is made that it is more effective than the traditional way. Many of the companies that have tried it found it successful and profitable, as have their employees. Some companies have failed.

Since 1937 I have lived with Allan Mogensen's dream of training and involving workers in improving productivity. We now know that the missing link all these years has been trying to get workers involved with no reward; it does not work. Give workers a piece of the action, a stake in the outcome, and their response is tremendous. Productivity in this country can be raised appreciably by putting into use techniques and concepts that were developed by Americans and are suited to our culture and way of life.

How one manufacturer moved from labor tension to productivity

By Patti Bullock
American Productivity Center

After nearly 40 years of union unrest, can a small manufacturer successfully involve its employees in productivity improvement? Can the employees expect to share in the financial benefits that increased productivity brings to the firm? The answer to both questions, based on the experience of the Corry Jamestown Corp., is definitely "yes."

Through a productivity sharing program called Improshare and a new approach to labor-management cooperation, Corry Jamestown recorded productivity gains of better than 17 percent in both 1978 and 1979. These have to be regarded as major accomplishments in a period when U.S. industry, in general, was edging into a productivity downturn.

Corry Jamestown, located in Jamestown, N.Y., is a wholly-owned subsidiary of Hon Industries, an office furniture manufacturer. Corry Jamestown manufactures metal office furniture products which are sold across the nation through a network of independent dealers.

Production and maintenance workers are represented by the International Association of Machinists and Aerospace Workers.

The company has a stormy labor history. Corry experienced its first strike in 1940, just after its labor force became unionized. There were two more strikes in 1948 and 1958 and another in 1975. The 1975 strike continued for nine weeks and was by far the most bitter in Corry's history.

After members of the Federal Conciliation and Mediation Service helped settle the 1975 strike, union and company representatives began to meet separately and jointly with the Jamestown Area Labor Management Coordinator. The purpose was to explore the avenues which might change the union-management relationship and benefit both parties.

Following a series of meetings, a Labor/Management Committee was established in the company. The committee is comprised of an equal number of top labor and management representatives.

The group's initial efforts at cooperation were strained and frustrating. Old ways of dealing with each other proved difficult to overcome. Fortunately for workers and for the company, the Labor/Management Committee did not give up and gradually, some encouraging results began to emerge.

Among the first successes were the clarification of a holiday qualifier clause in the contract, the creation of a new job evaluation procedure, and the establishment of an employee-of-the-month program.

The real breakthrough for Corry Jamestown management and employees came in 1978, with the establishment of the Improshare program. Through this program Corry Jamestown shares the benefits of productivity gains with the company's hourly employees.

The Improshare program is based upon the company's productivity level for a specified base period. Productivity gains are monitored against this base period on a monthly basis. To the extent that productivity increases, the financial results of the increase are shared equally between the company and the employees each month. In other words, of every dollar the company makes through improved productivity, 50 cents goes to employees in the form of monthly bonuses. This has proved to be a tremendous incentive toward employee involvement and commitment to productivity improvement.

The results on the company's side have been more than satisfactory. Productivity increased 17.2 percent in 1978, and jumped another 17.4 percent in 1979. These are significant numbers in any case, but even more significant in that they were achieved during two years when U.S. productivity in general was declining.

Labor and management leaders agree that the increases would have been impossible under their earlier more adversarial relationship. At Corry Jamestown the shared feeling is that labor-management cooperation and programs like Improshare pay off for both sides.

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Mr. FEIN. And there is another paper there called the "Job Security Plan," which is on a very timely subject today: job security.

Mr. LAFALCE. That, too, will be included as a part of the record.

[The information referred to above follows:]

January 11, 1982

THE IMPROSHARE® JOB SECURITY PLAN

Mitchell Fein

Abstract

The IMPROSHARE® Plan promotes cooperation between employees and company to raise productivity and share the financial gains.

As orders decline, productivity increases, or both, if the available orders are insufficient for the work force, layoffs may be caused. The IMPROSHARE® Plan can be converted to the IMPROSHARE® Job Security Plan, which protects employees against such layoffs. Improved productivity is rewarded by time off with full pay. When productivity is raised so that 40 hours worth of work is produced in less than 40 hours, the employees will be paid for 40 hours, though they work less time. Layoffs are thereby avoided.

Mitchell Fein, Inc.
Hillsdale, NJ 07642

January 11, 1982

THE IMPROSHARE® JOB SECURITY PLAN

Job security plans are generally designed to protect employees against layoffs caused by lack of orders. During depressed business conditions attempts by management to raise productivity are usually resisted by employees, who see increased productivity as leading to additional layoffs.

Workers have historically opposed productivity improvement efforts, fearing the layoffs to which improvement leads in the short term. Managers must recognize this fear in developing improvement plans.

> A program for productivity improvement must provide for workers' job security. Though management may not be able to protect against economic downturns, there is much that can be done. Since job security is a vital element of the work environment, managers must look upon job security as an essential precondition to enhancing the will to work.1/

The IMPROSHARE® Plan, which provides the rationale and methodology for sharing productivity gains between employees and company, can also be used to assure job security as productivity increases.

Productivity improves when the same number of employees produce more product, or when fewer employees produce the same amount of product, or with a combination of both. To produce more product, the company must be able to obtain additional orders over those normally obtained. Producing the same amount of product with fewer employees causes some to be laid off, since attrition is usually not sufficient to remove the surplus employees.

Under normal business conditions, obtaining more orders is usually not too difficult. More aggressive marketing, building better product or reducing sales prices can help to attract business away from competitors. When orders fall off, the company must use its best efforts just to hang on, let alone get additional orders.

Displacing workers is undesirable from all viewpoints. Displaced workers suffer; the morale of those who continue to work is impaired. The company also loses because when trained workers are laid off, training costs are lost and additional costs will be incurred in training new workers when normal business volume returns, as well as those who will ultimately be needed to replace older workers as they retire. Layoffs affect the community. Everyone loses.

Rationale of IMPROSHARE® Job Security Plan

Just as the IMPROSHARE® Plan encourages employees and company to cooperate in raising productivity and share the gains, so can

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cooperation be used to protect jobs in depressed economic conditions. Job protection can be established by changing the conventional IMPROSHARE® Plan so that instead of receiving money for increased productivity, employees receive time off with full pay. With normal business conditions increased productivity under IMPROSHARE® is shared 50/50 with employees as added pay. When business volume falls off, the IMPROSHARE® Job Security Plan calculates increased productivity into equivalent hours which are used as time off with full pay. The IMPROSHARE® Job Security Plan provides that:

- The company temporarily gives up its 50% share so that 100% of the productivity gain goes to a full week pay bank to avoid displacing employees.
- Productivity sharing money payments to employees are temporarily suspended.

The following illustrates the mechanics of the plan:

The conventional IMPROSHARE® Plan provides that when 100 employees produce what would have required 120 employees, the productivity gain is calculated as:

Output of 120 employees: 120 x 40 hours = 4800 hours
Input of 100 employees: 100 x 40 = 4000

100% gain = 800
50% gain = 400 hours

The 400 hours gained are shared by all employees, as 400/4000 = 10% to each employee; all 100 employees receive 10% of their weekly pay. The company also gains 400 hours as its share.

When orders can be obtained for only 4000 hours of product, if productivity increases in the same ratio as above, 83 employees will produce the output of the original 100. The mathematics is as follows: An increase from 4000 to 4800 hours equals 20%. The same increase with output limited to 4000 hours is 4000/1.2 = 3333.3; translated into full time 40 hour employees, only 83 (3333.3/40) will be needed.

Operating under the IMPROSHARE® Job Security Plan, if the 100 employees work 3333 hours in a week, which is 33.3 hours per employee, and they produce 4000 hours worth of output, each will receive 40 hours pay (4000/100 = 40). No one loses his job and the 120% productivity level is maintained. The inducement to work at a higher productivity level is to be able to work fewer hours and still be paid for 40 hours.

The IMPROSHARE® Job Security Plan (IJSP) is proposed as a temporary expedient for depressed business conditions to encourage increased productivity and still protect workers from layoffs. Everyone does not gain under IJSP compared to the conventional IMPROSHARE® Plan. If the 100 person work force in the previous example were reduced to 83, the 83 would receive 10% extra pay and

the company would save 400 hours pay. With IJSP the workers who remain and the company give up their productivity sharing monetary gains to protect the jobs of the 17 who are not displaced. The 17 workers who were not laid off are the real gainers. Without IJSP, the 100 employees would each work 40 hours to receive 40 hours pay; with IJSP the 100 work 33.3 hours and receive 40 hours pay.

Under IJSP both the employees and the company give up the productivity sharing gains they would enjoy under the conventional IMPROSHARE® Plan in exchange for paid time off for the employees and no layoffs.

Mechanics of IMPROSHARE® Job Security Plan

To make the plan practical and workable, employees work a regular 40 hour week and the extra hours earned through increased productivity are banked to be taken as days off with pay in future weeks agreeable to the employees and the company. The mechanics of calculating productivity gains is the same as for IMPROSHARE®, except that 100% of the gains goes to maintain full employment with 40 hours pay at reduced hours worked. Calculations for the IMPROSHARE® Plan are contained in the publications mentioned in footnotes 2/ and 3/.

The mechanics are illustrated in the accompanying form, CALCULATIONS FOR PRODUCTIVITY SHARING UNDER THE IMPROSHARE® JOB SECURITY PLAN, which uses only three of the nine columns used for 50/50 productivity sharing under IMPROSHARE®; columns 3, 4, 5, 6, 8 and 9 of the IMPROSHARE® calculation form are not used. The following changes are made:

- The moving average used to calculate 50/50 productivity sharing is replaced by calculations on a weekly basis. The original columns 1 and 2 are used and the moving average columns 3 and 4 are left blank.

- Column 5, which is used under IMPROSHARE® to bank hours produced above the maximum, and column 6 are not used, since the maximum concept is not employed under this plan.

- Column 7, 100% Hours Gained, is used to show the weekly gain or loss.

- Column 7A, Hours Used for Time Off, is a new column to show hours used to bring a short work week up to a full 40 hour week.

- Column 7B, Remaining Hours in Time Off Bank, is new; it shows the balance of hours available each week, accounting for hours gained and hours used for time off.

The following discussion refers to the calculation form, which shows how the plan would work for a typical 100 person group:

Calculations for Productivity Sharing Under Improshare® Job Security Plan

Week	Actual Hours Worked	Imp Hours Earned	100% Hours Gained	Hours Used For Time Off	Remaining Hours in Time Off Bank	Comments
	(1)	(2)	(7)	(7A)	(7B)	
1	4000	4100	100	-	100	
2	4040	4300	260	-	360	
3	4010	3950	-60	-	300	
4	3600	4100	500	400	400	
5	4000	4300	300	-	700	
6	3600	4050	450	400	750	
7	3950	4400	450	-	1200	
8	3200	3900	700	800	1100	
9	3600	3800	200	400	900	
10	3600	3500	-100	400	400	
						Columns 3, 4, 5, 6, 8 and 9, mentioned on pages 4, 6 and 7 are used on the Improshare Plan calculation sheet, but not for the Job Security Plan.

Week 1: Hours produced or earned is 4100, hours worked is 4000, hours gained is 100, shown in column 7; this carries over to the remaining hours available in column 7B.

Week 2: Hours worked is 4040, hours earned is 4300; hours gained is 260, with a remaining balance of 360.

Week 3: Hours earned is less than hours worked, which shows as minus 60 hours in column 7, reducing the remaining hours available to 300.

Week 4: Hours worked is 3600, hours produced is 4100, and the gain is 500. The employees and company decide to use 400 hours (they elected to take Friday afternoon off with pay) to bring total pay to 4000 hours, equal to 40 hours per employee; this brings the remaining balance to 400. The calculation is 300 remaining balance from Week 3 plus 500 gained in Week 4 minus 400 hours used in Week 4, for a remaining balance of 400.

Week 6: Employees and company decide to use an additional 400 hours to bring their weekly pay to 4000.

Week 8: Employees and company decide to work a 4 day week of 3200 hours, and use 800 hours of the 1200 hours available from previous Week 7, leaving a remaining balance in week 8 of 1100 hours.

When the IJSP is discontinued to return to the conventional IMPROSHARE® Plan, the moving average is picked up as if the first week after IJSP followed directly after the last week before IJSP.

When to implement the IMPROSHARE® Job Security Plan

Productivity measurement under IMPROSHARE® is always calculated by comparing the man hour value of output to the actual hours worked by the entire work force. Since IMPROSHARE® measurement standards include the work performed by all employees covered by the plan, the output in hours is compared to the total hours worked by all employees. There is no differentiaton between the hours worked by the various employees in the plan; everyone's hours are included in the productivity measurements.2/3/ This method of calculating makes it possible to determine accurately when business volume is sufficient to maintain the work force, and whether increased productivity will cause layoffs. For example, if 100 employees work 40 hours per week for a total of 4000 hours, and the work load to be produced each week is 4000 hours, input and output are balanced. Raising productivity in this instance would cause layoffs.

When orders for 4400 hours are available, the productivity of 100 employees working 4000 hours can increase by 10% and still not create layoffs. This approach permits employees and management to determine whether layoffs will be caused by raised productivity or by a shortage of work.

In the calculation sheet illustration, the 100 employee group is kept intact through a combination of improved productivity and short work weeks. Should orders fall off as is shown in column 2 in the latter weeks, a layoff may be necessary, but this would be caused primarily by a lack of work. When available work in hours is less than the actual hours worked by the employees, the IJSP cannot operate. Under an IMPROSHARE® Plan, since the hours of work available for the plant are readily determined, it is possible to calculate whether the hours of work are sufficient to support the hours to be worked by the employees. Whether or not there is a layoff at this point is a matter for decision by management, in consultation with the employees.

Converting from a conventional IMPROSHARE® Plan to the IMPROSHARE® Job Security Plan

The conventional IMPROSHARE® Plan distributes productivity sharing each week; there is no withholding of productivity gains except for hours that may be accumulated in column 5, Banked Hours. The 50% hours gained in column 8 is the moving average calculation of the weekly data for which the moving average is calculated. When the productivity share is paid each week, there is no carryforward to subsequent weeks. The moving average is just a way of mathematically levelling high and low weeks for consistency in productivity sharing payments.

To start the Job Security Plan, continue to use the Calculations for Productivity Sharing form used for IMPROSHARE®, but delete columns 3, 4, 5, 6, 8 and 9; instead insert columns 7A and 7B, shown on the sample calculation sheet. Each week's hours worked and hours earned are entered into columns 1 and 2; the calculations are as shown in the illustration.

When business volume returns to normal, the Job Security Plan is terminated and 50/50 sharing goes back into effect; cease the IJSP calculations and reestablish the original IMPROSHARE® productivity calculations.

Improved productivity benefits everyone

IMPROSHARE® provides a means to permit employees and company to share the gains from productivity improvement. Setting the base for sharing at the average of the past year, and freezing that base assures an equitable division of the improvement. The essentials of IMPROSHARE® are contained in "IMPROSHARE®: An Alternative to Traditional Managing."4/

Companies holding back from establishing an IMPROSHARE® Plan because of depressed business volume can start with the IMPROSHARE® Job Security Plan and change over to the IMPROSHARE® Plan when volume turns up.

When a company has been operating at an improved productivity level under IMPROSHARE®, as orders drop off the employees may slow down to avoid layoffs, even when dropping productivity reduces share payments. The cooperative spirit and attitude of employees and management made it possible to initiate the IMPROSHARE® Plan when business conditions allowed productivity to increase with a minimal impact on employment. The same spirit and attitude should carry over into periods of low business volume when additional orders are difficult to obtain and increased productivity will cause layoffs.

With the IMPROSHARE® Job Security Plan operating, everyone can cooperate and work effectively, reduce the work week when possible and use the Hours in the Time Off Bank (column 7B) to make up a full 40 hour pay check. Ingenious employees and progressive companies will find ways to implement the IMPROSHARE® Job Security Plan in ways suited to their operations and consistent with the IMPROSHARE® philosophy.

1/ Mitchell Fein, IMPROSHARE®: AN ALTERNATIVE TO TRADITONAL MANACING, Institute of Industrial Engineers, Norcross, GA 30092, 1981, p. 61.
2/ Ibid, pp. 42-46.
3/ Mitchell Fein, MEASURING PRODUCTIVITY FOR AN IMPROSHARE® PLAN, Mitchell Fein, Inc., Hillsdale, NJ 07642, 1980, 1981.
4/ Mitchell Fein, IMPROSHARE®: AN ALTERNATIVE TO TRADITIONAL MANAGING, pp. 46-48.

Mr. FEIN. All this improvement was attained by the cooperative efforts of workers and management to produce more units of product in fewer man-hours of work. Where new capital equipment was installed, the increase from the equipment was factored out. The increase was obtained by people efforts.

To cite several examples:

A plywood plant employing 150 workers in the International Woodworkers Union raised its productivity by 24 percent in 12 weeks and by 34 percent after a year, to make this plant the most productive plywood plant in the Nation.

A highly mechanized brick plant, whose employees are members of the steelworkers union, raised productivity by 30 percent in just 3 weeks.

A metal fabricating plant of 40 employees raised productivity by 10 percent after 12 weeks; 18 percent after a year; 4 years after starting, they are 30 percent over the base year.

A company producing metal office furniture, employing 550 employees in the machinists union, increased productivity by 17.2 percent the first year, 17.4 percent the next year; 4 years later, productivity improvement is still being maintained.

Of the plants, 38 are nonunion, 34 are represented by 18 different international unions. Productivity improved in all plants. The gains in the small plants are often more spectacular than the large plants, dispelling the notion that small companies do not have the abilities and opportunities to match large companies' technical and engineering resources.

Some of the companies in this high-producing group are plants of Bell & Howell, the Coleman Co., the Continental Group, Hon Industries, Firestone Tire & Rubber Co., General Electric, Hinderliter Energy Equipment Corp., Ingersoll-Rand, Koppers, McGraw-Edison, Prestolite Division, Rockwell International, Weyerhaeuser, and about 100 others. Many are small companies whose names are not readily recognized.

Managers of all these plants adopted the same approach: Involve all employees in cooperative efforts with management to raise productivity, and as productivity improves, all employees share in the productivity gains directly in their weekly paychecks.

The ground rules and mechanics for worker involvement and sharing are provided by the Improshare plan, which shares productivity gains 50–50 between workers and the company. Productivity improvement is shared, not profit; there is a great difference. Profit sharing splits economic gains. Raising prices may create a profit even when productivity is low. Conversely, productivity may be high and a company may operate at a loss. Obviously, if productivity were poor in this company, the loss would be worse.

Workers can help to raise productivity, but their actions may have limited impact on profit. Managements' decisions and actions have a greater effect on profits.

Asking workers to reduce their wages and give back fringes is retrogressive. I visit plants and meet with thousands of workers and managers. The state of the economy frightens workers and managers; their morale is low and sinking lower as newspapers and TV spread stories of plant shutdowns and workers taking pay cuts. Workers know the stories are true and events are hitting

them. This country needs to move forward and reduce costs by raising productivity, not by cutting wages. Our gross productivity and output per man-hour is higher than all other nations, including the highly touted Japanese. American workers are proud of their material wealth and ability to buy back a high standard of living. Their desire for more and more of the good things of life in turn creates more good jobs.

The No. 1 need today is increased productivity. Imagine the impact on the auto parts and assembly plants of this country if productivity were to increase by 9.4 percent in 12 weeks, and 22.2 percent in a year. With 50–50 sharing, labor cost savings would be half the increase. The increased plant throughput would create even larger cost savings. The total cost savings would go far to make high-cost American products more competitive in the international market. American workers in these 72 plants have shown they can outproduce by far the best productivity levels that had been attained in their plants before they started working under the productivity-sharing ground rules of Improshare. The results attained are very impressive.

General Motors, Westinghouse, Texas Instruments, Motorola and thousands of companies across the land agree that American workers can greatly help to raise productivity. Programs to involve workers in improvement efforts operate in numerous plants under titles such as quality of work life, quality circles and others. None of these programs, however, reward workers with money for improvements they create; rewards are nonfinancial and provide workers with a feeling of having contributed to their company's welfare and so also to their own job security.

A major conceptual difference between the nonfinancial reward programs like quality circle and equality of work life programs, and Improshare, is that Improshare rewards workers with increased paychecks for productivity improvement.

Differences in bottom-line productivity improvement between nonfinancial worker involvement programs and Improshare is seen in the results. Improshare raised productivity by 9.4 percent in 12 weeks; quality of work life and quality circle programs take 1 to 3 years to produce miniscule improvements.

The difference in worker attitudes and actions is seen in a meeting that took place in a large machine shop to discuss the introduction of an Improshare plan, at which were present operating managers and union committee representatives. In response to a question posed to me by the plant manager as to how long it would take for an Improshare program to start operating, I turned to a union steward from one of the large machine departments and asked him how long it would take for workers in his department to "rev it up." The response was, "15 minutes." This was not a flippant remark, but a considered statement by a knowledgeable worker of how long it would take him to turn up his production, if he wanted to. That is really the key: Getting workers to want to.

When workers want to make suggestions to increase productivity and to increase their own output, all they have to do is do it. It does not require a 1- to 3-year program to convince workers that increased productivity under a productivity-sharing plan benefits them financially and nonfinancially. When workers see the finan-

cial benefits the plan can provide and the opportunities open if they wish to become involved, they get into the spirit of the plan. In times of keen competition, helping the company to reduce costs will save jobs, which workers readily recognize. The magic ingredient that makes productivity-sharing work is the financial reward, reinforced as increasing numbers of workers join in the efforts.

The job restructuring and work design efforts through organization development, on through the quality of work life and the more recent quality circle programs, all have a common base: The main reward offered to workers for involvement in these programs is the satisfaction of having contributed to improvements in productivity and how work is performed. None offer financial rewards either as an inducement to participate or as a reward for improvements in work and in productivity.

I dispute the claims that the work itself is a primary motivator for most workers. I support the proposition that financial incentives, at least for manufacturing plants, is a more powerful means to encourage workers to increase their productivity and to accept management's productivity goals as congruent with theirs. The work itself is attractive to a minority of the work force. Increased earnings through productivity-sharing plans is attractive to all.

Experience in many companies and research show that:

Worker involvement programs which offer only job satisfaction as the prime reward for involvement will be supported by only a small proportion of the work force and tap a fraction of the potential for improvement in the organization.

Second, worker involvement programs which offer financial rewards by sharing productivity improvement with employees through formal productivity-sharing plans such as Improshare create high levels of involvement, produce results very quickly, and raise productivity to much higher levels than are attained by nonfinancial reward programs only. Details of the study of the 72 companies described in this presentation are contained in a separate paper entitled "Improved Productivity Through Worker Involvement." A copy has been furnished to the subcommittee.

Let me wrap it up by just saying this: Improshare is not an incentive plan in the conventional sense, though it shares productivity gains with employees. It is a philosophy of managing which is significantly different from the traditional way in which management views productivity improvement as a unilateral responsibility. In sharing productivity gains, employees accept management's productivity goals. The we-they adversary relationship changes so both gain together as they cooperate to produce more product or services in fewer man-hours. Productivity impediments and losses affect both.

Productivity sharing is a way of life. It is an alternative to traditional managing. No claim is made that it is more effective than the traditional way. Many of the companies that have tried it have found it successful and profitable, as have their employees. Some companies have failed.

Managers have been trying for over 50 years to train and involve workers to improve productivity. We now know that the missing link all these years has been trying to get workers involved with no reward; it does not work. Give workers a piece of the action, a

stake in the outcome, and their response is tremendous. Productivity in this country can be raised appreciably by putting into use techniques and concepts that were developed by Americans, and are suited to our culture and way of life.

Let me add—I thought of it when I wrote the paper, but I want to add it now—this concept is ideally suited to small companies, with 30, 40, 50, to 100 employees. Implementing a program like this literally takes several days. It is not a complex program at all. It does use industrial engineering techniques of a very simplified nature, pretty much as the two speakers here talked about, though they deal in broader aspects of mechanical problems. We deal with trying to get workers to produce more.

The knowledge, the skills, the abilities of American workers are enormous. They are not being tapped. The way we run our shops is we tell workers, "Come to work, punch in, do your job, and get the hell out of here. We don't need you. We run our shops with technicians and engineers. We have smart guys to run the shops." The worker does just that. His ability is not being used. We want to use that ability. We have demonstrated in loads of places that the results are just fantastic. Can you imagine raising the productivity of 72 companies in 12 weeks by 9.4 percent, and that includes 15 companies where it didn't work? The average is higher if you exclude the other companies. Can you imagine the impact that would have on the automotive industry, the automotive parts plants?

I think cutting wages and taking back fringes is the most horrible way we can think of handling the problem. We pass along all of our problems and difficulties to workers and say, "You pay for it." It just doesn't make any sense.

I think the goal and things we have got to strive for are to raise productivity and move forward; not to move backward.

[The prepared statement of Mr. Fein follows:]

PREPARED STATEMENT OF MITCHELL FEIN, PRESIDENT, MITCHELL FEIN, INC.

I am pleased to appear before this committee to describe how 72 American manufacturing companies, ranging in size from 30 to over 2,000 employees, raised their productivity on the average by 9.4 percent at the end of 12 weeks and by 22.2 percent after a year.

All this improvement was attained by the cooperative efforts of workers and management to produce more units of product in fewer man hours of work. Where new capital equipment was installed, the increase from the equipment was factored out. The increase was obtained solely by people efforts.

To cite several examples:

A plywood plant employing 150 workers in the International Woodworkers Union raised its productivity by 24 percent after 12 weeks and by 34 percent after a year, to make this plant the most productive plywood plant in the nation.

A highly mechanized brick plant, whose employees are members of the Steelworkers, raised productivity by 30 percent in just three weeks.

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A company producing metal office furniture, employing 550 employees in the Machinists Union, increased productivity by 17.2 percent the first year, 17.4 percent the next year; four years later productivity improvement is still being maintained.

Thirty-eight of the plants are nonunion, 34 are represented by 18 different international unions. Productivity improved in all plants. The gains in the small plants are often more spectacular than the large plants, dispelling the notion that small companies do not have the abilities and opportunities to match large companies' technical and engineering resources.

Some of the companies in this high producing group are plants of Bell & Howell, The Coleman Company, the Continental Group, Hon Industries, Firestone Tire & Rubber Company, General Electric, Hinderliter Energy Equipment Corporation, Ingersoll-Rand, Koppers, McGraw-Edison, Prestolite Division, Rockwell International, Weyerhaeuser, and about 100 others; many are small companies whose names are not recognized.

Managers of all these plants adopted the same approach:

Involve all employees in cooperative efforts with management to raise productivity.

As productivity improves, all employees share in the productivity gains directly in their weekly pay checks.

The ground rules and mechanics for worker involvement and sharing are provided by the Improshare® Plan, which shares productivity gains 50–50 between workers and the company. Productivity improvement is shared, not profit; there is a great difference. Profit sharing splits economic gains. Raising prices may create a profit even when productivity is low. Conversely, productivity may be high and a company may operate at a loss; obviously, if productivity were poor in this loss company, the loss would be worse.

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Asking workers to reduce their wages and give back fringes is retrogressive. I visit plants and meet with thousands of workers and managers. The state of the economy frightens workers and managers; their morale is low and sinking lower as newspapers and TV spread stories of plant shut-downs and workers taking pay cuts. Workers know the stories are true and events are hitting them.

This country needs to move forward and reduce costs by raising productivity, not by cutting wages. Our gross productivity and output per man hour is higher than all other nations, including the highly touted Japanese. American workers are proud of their material wealth and ability to buy back a high standard of living. Their desire for more and more of the good things in life in turn creates more good jobs.

The number one need today is increased productivity. Imagine the impact on the auto parts and assembly plants of this country if productivity were to increase by 9.4 percent in 12 weeks and 22.2 percent in a year. With 50–50 savings, labor costs savings would be half the increase. The increased plant throughput would create even larger cost savings. The total cost savings would go far to make high cost American products more competitive in the international market.

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General Motors, Westinghouse, Texas Instruments, Motorola and thousands of companies across the land agree that American workers can greatly help to raise productivity. Programs to involve workers in improvement efforts operate in numerous plants under titles such as Quality of Work Life (QWL) and Quality Circles (QC). None of these programs, however, reward workers with money for improvements they create; rewards are nonfinancial and provide workers with a feeling of having contributed to their company's welfare and so also to their own job security.

A major conceptual difference between the nonfinancial reward programs like Quality Circle and QWL programs, and Improshare®, is that Improshare® rewards workers with increased pay checks for productivity improvement.

Differences in bottom line productivity improvement between nonfinancial worker involvement programs and Improshare® is seen in the results. Improshare® raised productivity by 9.4 percent in 12 weeks. QWL and QC programs take one to three years to produce miniscule improvements.

The difference in workers attitudes and actions is seen in a meeting that took place in a large machine shop to discuss introduction of an Improshare® Plan, at which were present operating managers and union committee representatives. In response to a question posed to me by the plant manager as to how long it would take for an Improshare® program to start operating, I turned to a union steward from one of the large machine departments and asked him how long it would take for workers in his department to "rev it up." The response was, "15 minutes." This was not a flippant remark, but a considered statement by a knowledgeable worker or how long it would take him to turn up his production—if he wanted to.

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SUMMARY

Improshare® is not an incentive plan in the conventional sense, though it shares productivity gains with employees. It is a philosophy of managing which is significantly different from the traditional way in which management views productivity improvement as a unilateral responsibility. In sharing productivity gains, employees accept management's productivity goals. The we-they adversary relationship changes so both gain together as they cooperate to produce more product or services in fewer man hours. Productivity impediments and losses affect both.

Productivity sharing is a way of life. It is an alternative to traditional managing. No claim is made that it is more effective than the traditional way. Many of the companies that have tried it found it successful and profitable, as have their employees. Some companies have failed.

Managers have been trying for over 50 years to train and involve workers in improving productivity. We now know that the missing link all these years has been trying to get workers involved with no reward; it does not work. Give workers a piece of the action, a stake in the outcome, and their response is tremendous. Productivity in this country can be raised appreciably by putting into use techniques and concepts that were developed by Americans and are suited to our culture and way of life.

REFERENCES AND ADDITIONAL INFORMATION

Mitchell Fein, Improved Productivity Through Worker Involvement, Mitchell Fein, Inc., Hillsdale, NJ 1982

Mitchell Fein, Improshare®: An alternative to traditional managing, American Institute of Industrial Engineering, 25 Technology Park/Atlanta, Norcross, GA 30092, 1981

ABOUT THE AUTHOR

Mitchell Fein is a consulting industrial engineer primarily concerned with solving the people problems that arise between employees and management that retard productivity. Since 1937 he has served over 500 companies in a broad range of industries, concentrating on developing ways of increasing productivity.

He has written numerous articles for technical and trade journals and sections in the Industrial Engineering Handbook (3rd ed) and Handbook of Business Administration (McGraw-Hill) and Handbook of Industrial Engineering (John Wiley). A

Work Measurement Handbook is in preparation for Prentice Hall. Mr. Fein lectures extensively to management groups in the United States and abroad.

Mr. Fein is active in the American Institute of Industrial Engineers, was Vice President of Publications of the Institute and is Research Chairman of the Work Measurement and Methods Engineering Division of AIIE. He is a member of eleven professional societies and a Fellow of AIIE and SAM. Mr. Fein was Adjunct Associate Professor of Industrial Engineering at New York University, College of Engineering.

He serves on the arbitration panels of the American Arbitration Association and the State Mediation Boards of New York and New Jersey. He is a graduate of New York University, a registered Professional Engineer in New York and New Jersey, and is a Certified Management Consultant of the Institute of Management Consultants, Inc.

Mr. LAFALCE. Thank you very much for your testimony, Mr. Fein.

Let me ask you to explain briefly some of the details of the Improshare general plan, other than the fact that it is a 50–50 sharing between labor and management of the productivity gains. Could you flesh that out a bit?

Mr. FEIN. All the details are contained in another paper that I provided to you. It is a monograph called "Improshare, an Alternative to Traditional Managing." As a matter of fact, this copy was published by the American Institute of Industrial Engineers. I just had it reprinted at a much lower cost.

Let me just describe this to you. I can tell you about the details. The measurement system is very important. Instead of measuring in detail worker by worker, we measure the aggregate of the entire company. Everybody is involved, whether you are a floor sweeper, machine operator, receiving clerk, maintenance mechanic, and others like that. Everybody is involved.

If I have a few minutes, let me go a little deeper here so that you understand it. I start with this question: We have a manufacturing plant. Can we run this shop without the floor sweeper? If you think about it, you think, well, someone has got to sweep the floor. What is the person there supposed to do? Not to sweep the floor; to help make product. Sweeping the floor is needed to make product; so are maintenance mechanics, shipping, receiving people, all kinds of jobs. Can I run the shop without the switchboard operator? We don't think of the switchboard operator as making product. I say the switchboard operator is there to make product because I can't run the shop without the switchboard operator. So we go into the office, in accounting, personnel, purchasing, expediting, invoicing. If you ask each of these workers what their task is, they reply, "I am a billing clerk; I am a personnel clerk." I say, no; everybody makes product because everybody is needed to make product.

Using that concept of involving all employees and the goal of this big plant is to make product, we then develop a way of measuring how many hours it took historically, how long it took in a base year, the year just passed, how many hours it took of all the people to develop each one of the products. We have plants with hundreds of thousands of products. It sounds very complex, but it is not complex at all. There are various easy ways of doing it.

Then the whole thing becomes input-output. For example, if 100 employees work 40 hours, then they worked 4,000 hours that week. If we produced 5,000 hours worth of work, we gained 1,000 hours. Split in half, the shop gets 500 hours spread among them all, and

the company saves 500 hours. The 500 hours of the shop, divided among 4,000 hours work, is ⅛ or 12.5 percent. Everyone gets 12.5 percent more money, and the company's costs have gone down.

Mr. LAFALCE. Just for that year?

Mr. FEIN. Just for that 1 week. It is done on a weekly basis on what we call a moving average. It goes into the weekly paycheck. We measure week by week.

Mr. LAFALCE. How often do you change the base?

Mr. FEIN. Never.

Mr. LAFALCE. The base remains permanent.

Mr. FEIN. That is right. That is a very key point. You are very sharp on that. It is the changing of the base which causes problems, because workers say if they work harder, they are going to keep tightening the base. We don't do that. So we freeze the base; that is one of the important things.

Mr. LAFALCE. Has management accepted the freezing of the base historically?

Mr. FEIN. It depends. We have another set of rules we call traditional work measurement. Work measurement is my field. In traditional work measurement, we keep changing the base.

Mr. LAFALCE. It seems to me that you always have to have increased productivity, and also increased labor productivity. Unless you have some mechanism for changing the base which is fair to both labor and management, you might not be successful.

Mr. FEIN. No, it is not changing the base that makes it work. The workers say, I innovated the idea. We used to make 100 pieces an hour. I found a way to make 200 pieces an hour. But if the boss picks that up, where the hell am I? I won't do it. We don't innovate. It is that kind of thinking which has stalemated the whole process. So workers say, You do it, boss, I am going to go along for the ride. I get paid by the hour. I get paid for breathing. I don't have to work. You run the shop. You improve the production. Go do it.

What we have now is that we are on a plateau. There is no labor productivity improvement going on in this country, nothing that you can really count.

Mr. LAFALCE. How do you distinguish between labor productivity improvement and total factor productivity improvement?

Mr. FEIN. There is a gross misunderstanding, I believe, about the whole question of productivity. Let me illustrate it by stepping back a bit.

In the late 1800's, 60 percent of the population worked on the farms to feed the Nation; today it is about 4 percent. Where did this come from? Capital equipment technology, seeds, and fertilizers. The old farmer with the horse and plow worked very hard. The modern farmer rides a tremendous piece of equipment. This tremendous increase did not come from worker productivity improvement; it came from capital equipment technology.

I go into a plant. I have an old engine lathe. I replace it with a turret lathe and I get roughly a fivefold increase. What did it? The machine did it. I go from a turret lathe to a machine we call a chucker, which is an automatic turret lathe. I get another fivefold increase. I have gone 25 times from the engine lathe to the chucker. The worker on the turret lathe works physically hard.

The chucker operator pushes buttons, yet we get a tremendous increase. It didn't come from the worker; it came from the capital equipment technology.

I had a typist in 1920 with an old typewriter, and we move on to electric typewriters. The speed or the productivity of a typist in——

Mr. LAFALCE. I understand that, Mr. Fein. In other words, it is important to distinguish between the different types.

Mr. FEIN. That is right.

Mr. LAFALCE. What mechanism is established so that there can be an accord between labor and management as to the division of responsibility for different types of productivity improvements?

Mr. FEIN. What do you do with it? I assume that is part of the question.

For ease we define that something which costs $10,000 or more installed for productivity improvement is called capital equipment. It is a very simple and arbitrary definition. If it costs less than that, we don't recognize it, and we share 50–50. If it costs more than $10,000, 80 percent of the savings generated by the equipment are taken out of the standard. The workers get half of the 20, or 10 percent. Management gets 90 percent of the capital equipment installation, and all the workers share that 10 percent. That is equitable and acceptable. Unions accept that. It is a very simple definition. The whole plan is based on a very, very simple definition. As a matter of fact, the whole plan is four pages long.

Mr. LAFALCE. Have you over the years had any interface at all with individuals or agencies within the Federal Government to try to get the Federal Government to promote, if not the concept of Improshare across the country, at least the general concept of sharing of human resource productivity gains between labor and management?

Mr. FEIN. I am a consultant to the GAO. It was Brian Usilaner who recommended me.

Mr. LAFALCE. Mr. Usilaner testified yesterday, and recommended that you testify before us today.

Mr. FEIN. I was very hesitant to come down. I have no confidence in any Government agency of any kind. I think it is all a big waste. I want to be very honest. We talk and talk and talk, and nothing happens. We talk to a company and it happens like that. I just have no confidence in—it is either a 2-year or a 4-year cycle. It is either an elected or appointed person. The rest of them are civil service, so no one gives a damn of any kind. You can drop dead and no one cares.

Mr. LAFALCE. No institutional mechanism for it.

Mr. FEIN. We know what is to be done. All the things we talk about can be done in Government agencies. It is like talking to the wall.

Mr. LAFALCE. Most of your experience as an industrial engineer is with the manufacturing sector; correct?

Mr. FEIN. No. There is service, banks, insurance companies, warehousing, all kinds of people. The common denominator is people, people working. It doesn't matter what they do.

Mr. LAFALCE. Yes. Do you have any more difficulties implementing Improshare in the service sector of our economy as opposed to

the manufacturing sector because of a greater difficulty in measuring productivity?

Mr. FEIN. You have a point. You have to be able to quantify units. Take, for example, an insurance company; we can quantify units of work. A big insurance company is a paper shuffling factory. I have increases from social security; I have had increases from Internal Revenue Service, and some of the other agencies in Government.

I think there is a real interest. I think there is a higher interest today in raising productivity than ever before. I have no confidence that anything will be done, just based on the past. But it can be done. In other words, you have some Government agencies, you can have 10,000 people sitting in a building. What are they doing? They are moving paper from this pile to that pile. I am not trying to degrade the work; the work has to be done, but we can get unit counts on it. Loads of work have been done on developing ways of measuring productivity. There just has to be the desire to do it.

Actually, it happens to be more than 72 companies. I had to finish that paper about 3 weeks ago because of the deadline. When the deadline came, I had to print the thing. I had to put a line, and that was the 72 companies. There were well over a 100 companies, but we have a tremendous record there now. A large number of companies, General Electric, Firestone, loads of others, that have had remarkable results, and loads of small companies. Some have failed. We now know enough on how to do it. The point is that the knowledge that workers have is just tremendous.

Mr. LAFALCE. There is a wealth of knowledge there.

Mr. FEIN. We can run the shops without supervisors because the guys know what to do.

Mr. LAFALCE. Probably more so than the supervisors in many instances.

Mr. FEIN. That is right. But we show the worker, we bypass the worker. We tell him, "You do as we tell you to do."

Mr. LAFALCE. I see. I applaud you and your company for the fine work you have done on the average. You did mention that your averages also included your failures. I shouldn't say your failures, but the failures of a certain minimum of companies, I think you said 13 or 15.

Mr. FEIN. Actually there were five failures. The rest were several plants that were shut down because of the business conditions, two of them had labor difficulties. There were different reasons. They were not plan failures. But there were five plan failures.

Mr. LAFALCE. What lessons can we learn from those failures? What were some of the reasons for the failures there?

Mr. FEIN. The main reason is stupid management, which is the biggest problem we have all over. Managers don't have a monopoly on brains.

Mr. LAFALCE. Could you expatiate upon that a bit?

Mr. FEIN. Where the plan is established, there has to be—as I mentioned—a change in philosophy. As a matter of fact, I can illustrate it by a simple story. Whenever I get home, my wife, who is involved with me in my work says, "How did it go?" I always say, "I met a wonderful bunch of people." She says, "You always say that." I thought about it and it occurred to me that only nice guys

want to share; SOB's don't want to share. It is a very important point. We have to have a management group that feels that workers are important. We want to work with them, and we want to share the gains.

Mr. LAFALCE. Yes.

Mr. FEIN. There is nothing wrong with the traditional way of operating, which is the way that all plants are run. But management runs the show. We have created a very high standard of living, tremendous levels of productivity, with traditional managing which tells the workers, "We tell you what to do, do it." I am not finding fault with it.

I am just trying to show that there is an alternative. The alternative is where the management says, "We want your ideas, we want your cooperation, we want your help, we want your inputs, we want all of that, and we want to share." Now some companies have looked at this and say, "Boy, if we could only get half of that, fantastic." They don't buy into the concept. They are not willing to accept that way of working. They operate in the old traditional way. Workers sense it and say, "Boss, go screw." And you are back again to a situation where the workers say that the boss didn't mean it.

It has nothing to do with union or nonunion.

Mr. LAFALCE. Yes.

Mr. FEIN. We have an adversary relationship in all areas of work, I think worse in the public sector than we have in industry. The kind of strikes we have with policemen, firemen and other agencies would be intolerable and put the companies out of business. Union workers in the private sector know you push to a certain point and then you let up because you will have no company and no job. But in the public sector, it seems that the Government can't go out of business, so the hell with it; we can do whatever we want to. But it is an adversary relation, and it has nothing to do with the profit motive. It has to do with the boss, and the boss could be a Government agent or it could be a manager in private industry. There has to be a rethinking of the whole thing, you see.

There is no question we can go to much higher levels, and many companies are doing it. General Electric, for example, has started one plant in Shreveport, another plant will soon start in Hickory. They are trying these as experiments. Weyerhaeuser has a plywood plant, and they are now starting a second plant. All kinds of companies are working with the thing. Firestone has started one and there will be several others going on; those are small ones.

Mr. DUDLEY. I would like to share something along those same lines, since you are asking about the problem of management.

Mr. LAFALCE. Please do.

Mr. DUDLEY. The Georgia Productivity Center publishes a newsletter that is distributed to 4,000 manufacturers in the State.

Mr. LAFALCE. Yes.

Mr. DUDLEY. In the fall of 1981, I conducted a survey of our readership to determine what their productivity interests were. We talked about computers, robots, programable control, and management ideas; 500 surveys were mailed and 25 percent responded. When asked, "What are your primary problems in productivity?"

firms listed high capital costs first, and inadequate management communication—the subject Mr. Fein was addressing—second.

Mr. LAFALCE. That is interesting.

I thank you very much for your testimony. I am afraid we are going to have to conclude this morning's hearing for a number of reasons, primarily because another subcommittee on which I serve is having the Department of Treasury testify, beginning 10 minutes ago, on some financial institutions and housing legislation. I have to get there.

I think the testimony we heard, both yesterday and this morning, has been extremely interesting. Yesterday, we heard from Mr. Joji Arai, the director of the Washington office of the Japan Productivity Center; Brian Usilaner, the Director of the National Productivity Group of the U.S. General Accounting Office, and John Stepp, the Director of the Office of Labor-Management Relations Services, U.S. Department of Labor.

This morning, we have heard from Bernard Sallot, the executive director of the Robot Institute of America; Egils Milbergs, Director of the Office of Productivity, Technology and Innovation, Department of Commerce; and you three gentlemen. I think there has been a general trend: All of you have pretty much agreed, I think, that the primary problems of productivity lead back to poor management in the United States. I heard that from Mr. Arai of the Japan Productivity Center. I heard that from Mr. Milbergs of the Department of Commerce this morning. I heard that from Mr. Fein right now, and you two gentlemen from the Georgia Productivity Center. I think that there are great lessons to learn from that. I also think that it is quite obvious that there are a number of things which need to be done, based upon the testimony we have heard. First of all, we need a much greater cooperative role between Government, labor, management, and academia than we have had. Second, it seems clear that we must give greater attention to the role of small businesses in the United States and the way that various programs in either the public or private sector can be of assistance to them.

We have to embark, it seems to me, on an outreach program for the small business community, very similar to the type of outreach program that the Georgia Productivity Center has. Above and beyond just talking about quality circles and quality of work life, et cetera, we must understand that in order to get the participation of the worker in the pursuit of greater productivity improvement, we have to involve him financially as well as physically.

With those brief remarks, we will conclude today's hearing. I will be preparing a summary of the hearings for the benefit of all my colleagues. We will also be working on some legislation, too, that I have been thinking of over the past weeks and months. For example, perhaps some targeted programs similar to the programs that Japan has, just for the small business community.

Perhaps, too—and I feel strongly about this, and I will be working with the Department of Commerce and with the association of various engineering societies—we might need legislation similar to the legislation we had in the post-Sputnik era giving special attention to the dire need we have for improvements in the quality and quantity of scientists and mathematicians and engineers in Ameri-

can society. We had the National Defense Education Act in the late 1950's. Perhaps we need a similar National Defense Education Act today, including productivity as an important means of improving the defense of America and the economy of America.

Mr. FEIN. May I make one point about the Georgia Tech program?

Mr. LAFALCE. Yes, Mr. Fein.

Mr. FEIN. I have been in the consulting field for 40 years. I am personally familiar with practically all the consulting firms in this country. I think a program such as theirs would help small companies immensely, probably more than anything else.

Mr. LAFALCE. Certainly any program that has a 22 to 1 cost-benefit ratio.

Mr. FEIN. No, for another reason. Small companies get sick and don't know it and don't know where to go, and they are afraid to go to an expensive specialist. They can provide that kind of impetus and knowledge and confidence, and then they can turn around and turn to a private consultant, but these little companies need it desperately. Maybe the Government can supply some seed money for the States. That kind of program is pretty much patterned after the agricultural program. I think it is just tremendous. If you could do that one thing, that would be one of the best things you could do.

Mr. LAFALCE. That is exactly what we were talking about yesterday, Mr. Fein, when you weren't here, trying to come up with some type of a program for the small businessman-nonfarmer, similar to the small businessman-farmer, where we have cooperative extensions in virtually every single State in America. It really has been the primary reason for the improvement in the agricultural productivity in the United States, which enables the United States to be the breadbasket for the world.

The first thing we have to do in that endeavor—what this subcommittee will be doing—is look into the implementation of the Stevenson-Wydler Act, which could, in some small way, be a harbinger of things to come, if implemented. But, apparently, this administration isn't implementing even that, at least as that came out from the testimony of Mr. Sallot of the Society of Manufacturing Engineers.

The subcommittee will adjourn.

[Whereupon, at 11:46 a.m., the subcommittee adjourned, to reconvene subject to call of the Chair.]

APPENDIX

ROBOT INSTITUTE OF AMERICA
ONE SME DRIVE • P. O. BOX 930 • DEARBORN, MICHIGAN 48128

RECEIVED
APR 27 1982

April 22, 1982

The Honorable John J. LaFalce
U.S. House of Representatives
2447 Rayburn House Office Building
Washington, DC 20515

Dear Mr. LaFalce:

It was a pleasure to participate in the subcommittee oversight hearings on productivity, even though the lead time involved did not permit me to prepare as well as I might have liked. I did enjoy very much the opportunity for the informal, and I believe fruitful, exchange which we had over a fairly extended time to develop some of the issues involved in productivity. My failure to respond sooner in forwarding to you the information which I mentioned to you in the testimony has been due to a rather extensive travel schedule. All of this information is enclosed and listed on the enclosed sheet. The corrected copy of my testimony is also enclosed for the record. As an aside, when one sees the transcript of informal testimony, it is sometimes a little bit different then one might have imagined. In any event, I did not change the substance of what I said. Later in this letter, I will clarify a couple of points that I feel need to be made.

The enclosed material includes the specific papers which you wish to include in the record from the Robot Institute of America and the Society of Manufacturing Engineers, all of which deal with productivity, the relative productivity positions of the United States and Japan, and the official support of the Society for the Cooperative Technologies program as it ultimately emerged in the Stevenson-Wydler Act (Public Law 96-480). These documents are particularly important because of the rather extended discussions we had on the implementation of the public law.

Concerning your question for the specifics of what our organization has done in the past to enhance education, I call your attention to the creation of a Manufacturing Engineering Education Foundation by the Society of Manufacturing Engineers, which, to date, had distributed over $1 million in grants to further the cause of education, training, curriculum development, and research aids to encourage the development of Manufacturing Engineering Sciences. Many special reports on the field of education are enclosed, along with some technical papers in layman's language, that point out the importance of new technologies on our industrial base and on our educational system. Please feel free to include any of these in the transcript record of the hearings, as you wish.

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Pursuing and focusing some of the thoughts expressed conversationally, I think the following are extremely important in the small business climate in which we find ourselves today:

1. Small business is being hurt and hurt badly in today's climate as witness to the recent reports on doubled small-company bankruptcies and failures. Many of the new and emerging technologies which have great potential to enhance productivity rest with the small business developers and implementers. The present business climate and philosophy is seriously impeding the development of such technologies as robotics, computer aided design and manufacturing, and others. The robotics industry, particularly, is small-business-oriented, at least until recently. It simply cannot internally generate the capital necessary for increased R&D to stay abreast of our internationl competitors in order to implement its plant expansion and industrial growth, and to properly service its markets. Further, it is almost impossible for it to procure this capital from sources outside itself because of the general climate of uncertainty, the current recession, and the literally "out of this world" interest charges for capital.

   It appeared as if the leasing provision in the recently enacted tax law would permit those businesses and industries which badly need technological modernization to have a means for the infusion of capital into their modernization plans. Just as it seemed this might be about to happen, the entire subject of leasing was "killed" by the action of an individual in the Senate. Though such leasing may cost the government tax revenue, the lack of substantial profitable industrial companies also generates an extremely large lack of revenue. In other countries, direct government loans are made to small industries to support their modernization and product development. We do not have that in the United States, so the leasing provisions of the tax act were at least some resemblance of a substitute.

2. The present climate of uncertainty in the general business and industrial areas as well as the inability of our government to come to grips with its budget situation may well deal a small blow to our small business industry, from which it may never conceivably recover -- at least not to the full potential which it would enjoy in a normal reasonably predictable climate. This climate may well cause the United States to more rapidly lose its technological lead to other nations in the high technology area.

3. Industry and business, which has suffered for 30 years from over regulation, control, and imprudent national and taxation policies cannot overnight be cast adrift to fend for itself on the philosophy that "the private sector can take care of everything better than the government can." This philosophy is undeniably true, but it has to be recognized by the government that there must be a transition period. During this transition period, certain aids must be offered as industry and business once again assume control of their own destinies in the free enterprise system.

4. The transfer of technology from one sector of our economy to another is vital to the massive improvements in technology required to once again assume our world leadership. This transfer of technology must be encouraged by our government in every means possible.

5. Finally, our government must understand that individual companies cannot play the role of government in financial matters. There is no company in the United States that, in order to sell its products, can borrow at 17% and subsidize itself or its customers with a 5% loan. For example, Japan recently subsidized, with a 5% loan, the sale of $250 million worth of subway cars to the city of New York by the Budd Company. An additional $800 million worth of cars should follow in the near future. The Budd Company cannot loan its customer the money to purchase its products at a 5% interest rate and suffer a huge loss. Only the U.S. government can do this when required in order to meet national competition of other government's subsidies on a head-to-head or equal basis. In this particular case, it was not quality, engineering, product design or any other factor that lost this order to the Japanese. It was simply the inability of the company to achieve equitable financing terms, and our government refused to intercept and support the sale with an equivalent low cost financial loan.

6. As this letter is written, I have just received word that the Office of Technology Assessment has the approval of Congress to embark on an extensive study on the field of automation and robotics. RIA and SME will be cooperating to the fullest. The study is the result of a high technology workshop conducted by the OTA in July of 1981, which was assisted by the Manufacturing Studies Board of the National Research Council and the Robot Institute of America.

I could make many other points on this subject since it is so extensive and so complicated. Both the Society of Manufacturing Engineers and the Robot Institute of America have been actively and vitally engaged in attempting to enhance the productivity of the United States over the past ten years, and in the process, have cooperated extensively with the Congress and the Executive Branch. We continue to aggressively play this role on behalf of our 63,000 members and the companies in the industrial base in the United States that support them.

Once again, I enjoyed very much the opportunity to testify on this subject. I will be glad to work with you and your staff in a continuing effort to solve our many problems. We will also be pleased to provide, as applicable, the support of our members in any way that they can assist.

Sincerely,

Bernard M. Sallot

Bernard M. Sallot
Executive Director

EMS:sm
Enclosures

ROBOT INSTITUTE OF AMERICA POSITION PAPERS

Policy Document No. 1
March, 1981

The Decline of Productivity and the Resultant Loss of U.S. World Economic and Political Leadership

Robot Insitute of America
One SME Drive
P.O. Box 930
Dearborn, Michigan 48128

Limited quantities of this report are available at no cost from: Robot Institute of America ● P.O. Box 930 ● Dearborn, Michigan 48128

After little more than 200 years of existence the United States faces economic survival challenges from Japan and other nations. Our productivity rate has declined while theirs has gained disproportionately using our technologies, products and know-how. Massive outflow of entire U.S. industries and jobs to these countries has occurred. Our loss of lead will be total in 1990 unless we change our policies, set national goals and change our tax laws and regulations to encourage greater use of technology, accompanied by massive doses of capital to apply it to our industrial system. To do so, we must attain a 4%/year compounded productivity rate. The challenge is horrendous. But we must meet it if we are to survive and regain our world leadership.

Robot Institute of America
Executive Committee:
Stanley J. Polcyn, *President*
Walter K. Wiesel, *Vice President*
Michael Radeke, *Secretary*
Richard G. Abraham, *Treasurer*
John A. Fulmer, *Past President*
Bernard M. Sallot, *Executive Director*

The Decline of Productivity and the Resultant Loss of U.S. World Economic and Political Leadership

Executive Summary

The purpose of this paper is to explore the decline in U.S. industrial productivity and to assess what can be learned from the productivity successes in Japan and Germany. As the world's most affluent nation, the U.S. is suffering from a negative trend in productivity that can be reversed by:

1) Encouraging industry and government to invest in applied and new technologies.
2) Setting depreciation schedules that are more compatible with the real world of obsolescence. Grant special tax credits for the added risk involved in accepting and installing new technologies.
3) Changing the patent laws to permit individual innovative entrepreneurs to retain adequate proceeds from their inventive efforts. Transferring dormant technologies from the public sector to useful job-creating products and processes in the private sector.
4) Encouraging individual savings and investment.
5) Encouraging, by tax law changes, the formation of small enterprises based on new research and technology (fall off in rate of formation of small firms since tax law changes in 1969 and again in 1976 are almost total).
6) Encouraging development of meaningful interface mechanisms to permit timely in-flow of new foreign technologies to the U.S.
7) Accelerating the development of government policies, legislation, and regulation designed to encourage more effective use of our human resources, through training, education, and recognition of financial support needed for new and evolving skills and technical careers.
8) Streamlining the myriad components of the Government, Executive Branch, Congress, technical and scientific committees, etc., to work more efficiently to identify goals and promote policies leading to the rapid solution of our productivity problem. Terminate endless, time-consuming and self-serving cosmetic debate, and replace it with action and solution-oriented agreemnt.
9) Directing top management in acceptance of the role of new technologies and committing their enterprises to these applications and uses.

THE UNITED STATES AS A WORLD ECONOMIC POWER

The United States, after some 200 years of official existence, has reached a critical point in its growth, facing serious obstacles to further expansion and development.

It is the objective of this report to define our current problem, suggest that a portion of its solution can be met by increasing technology, particularly in robotics, and point out how Japan, our chief economic adversary, has met its own problems and challenges. The paper will suggest that emulation of Japan will ultimately be our most rapid solution to the problem. President Reagan has said that our "current situation borders on the calamitous" and "that we must seek both drastic and positive solutions." Included are the steps necessary, in the opinion of the Robot Institute of America, to regain our lost productivity dominance.

The importance of productivity growth cannot be overstated. It is a contributor to, and an indicator of, the effective annual net growth of the Gross National Product.

THE PRODUCTIVITY PROBLEM

In absolute terms, the United States still leads the rest of the industrialized world in productivity. In terms of productivity growth, an extremely important economic measuring tool, the United States now lags all other industrialized nations.

The importance of productivity growth cannot be overstated. It is a contributor to, and an indicator of, the effective annual net growth of the Gross National Product. Latest Department of Commerce figures show that the rate of growth of U.S. GNP is declining in real terms:

1976	*5.7%*
1977	*4.9%*
1978	*3.9%*
1979	*1.9%*
1980	*2.0%*

If we are to make increasingly severe demands on the GNP—in terms of wage and salary improvements, a growing fixed burden of Social Security, an adequate national defense, the growing cost of environmentalism, and the creation of job opportunity—it follows that the effective real GNP must have at least a corresponding growth to offset their costs. Otherwise, we will be unable to maintain our present standard of living and fail to regain our worldwide competitive position.

Since 1970, the United States productivity growth has declined due to lack of investment capital, diminished research and development, excessive regulation, conflicing taxation policies, misdirected anti-trust policies with punitive and indecisive enforcement, and finally, ineffective technology transfer. These factors have been compounded by our overall fixation on immediate benefit at the expense of long range solid gains in almost every aspect of our political and economic lives. With all this, our obsession with due process has created an adversarial institutional relationship that has rendered it impossible to achieve national policy consensus, set national goals, and agree on reasonable programs to implement them.

The U.S. can no longer afford to delay the acceptance of the productivity challenge.

Only through the efficient creation of agricultural and industrial products can we have the means to maintain our standard of living, world competitive position and be able to distribute wealth for the benefit of the less fortunate in the United States and the rest of the world. The U.S. can no longer afford to delay the acceptance of the productivity challenge. What may have been dismissed as an unfortunate irregularity in economic cycles 5-10 years ago, has become a persistent signal that cannot be further ignored if we wish to have a strong economy and a prosperous nation.

Most critically, we need to design the improvements of productivity as a priority national goal. This will focus the industrial, legislative, academic and public groups on a positive approach that will generate constructive policies, actions, and behavior. We have spent an incredible amount of personal energies and resources in "precise" definition of the problem, attempts to "precisely" measure it, and "precise" solutions amid profuse and voluminous cries over our plight.

Understandably, this has resulted in a climate dominated by policies of restraint, prohibition, regulation, controls, and adversarial litigation as incomplete solutions to the fundamental problem.

The time has come to cease "defining the problem" and adopt positive "bottom line" policies and approaches to achieve a solution.

BACKGROUND

Following World War II, and prior to the current period, inflation (2%-4%) and lack of a continually increasing standard of living was seldom a problem; Why? Because our "productivity" always outdistanced inflation and permitted large increases in our standard of living. The years since the war have generated the fantastic and never before achieved yearly average growth of 3.2%. But it has taken us a mere 12 years (since 1967) to fall to a yearly gain of less than ½ of 1% (1979)—and in the past 12 months to become negative (-2.0). Massive reports by the U.S. General Accounting Office, the Department of Commerce, Congress, the Executive Branch and literally hundreds of organizations and individuals support this conclusion.

The time has come to cease "defining the problem" and adopt positive "bottom line" policies and approaches to achieve a solution.

Exactly paralleling this 10 year period, we have seen:

a) Accelerated inflation at an 18% annual rate, with a 50% decline in the purchasing force of the dollar.

b) Decreased living standards and rising unemployment.

c) Declining capital formation and investment.

Percent of Gross Domestic Product invested annually in plants and equipment is declining rapidly. For 1979 and 1980, it is estimated to be nominal.

1947-1967	3.0%
1967-1973	2.5%
1973-1977	1 3%
1977-present	+ 1.0%

Alarming are the 1978 Department of Commerce figures on new plant and equipment orders:

Nov. 1978	7.4% decline (over year before)
Dec. 1978	3.8% decline (over year before)

Annual capital investment is lagging by comparison with our foreign competitors. (There is a direct correlation between our declining capital investment in new plant and technologies and the increasing number of plant closings and loss of jobs.)

Since the Tax Reform Act of 1976, capital investment per worker has almost vanished in the United States.

Specifically, capital investment per worker in the U.S. is falling rapidly, while capital invested per worker in our competitor nations increases.

	1967	1973	
West Germany	$298	$693	per worker
Japan	$191	$324	per worker
United States	$258	$220	per worker

Since the Tax Reform Act of 1976, capital investment per worker has almost vanished in the United States.

Finally, our source of capital from individual savings is rapidly drying up. To begin with, the rate of personal savings in the U.S. is 3 to 4 times less than in Japan and Germany (Japan averages 20%, the U.S. 5%) and even that rate is declining, caused by the dramatic rise in inflation and the Tax Reform Act of 1976.

Rate of individual savings (U.S.--% of GNP)

1976	7.5%
1977	1.5%
1978	5.3%

New business starts dropped to almost zero in 1979-80. Failure to adopt new technologies and invest massive amounts of capital in new plant, equipment and modernization was directly related to plant closings and loss of jobs.

d) Catastrophic negative trade balances.
e) Continually increasing government transfer payments made from a declining pool of industrial and agricultural wealth.
f) Loss of historical competitive markets causing increased dependence on military rather than economic power to maintain a world leadership position.
g) Forced abdication of leadership positions in basic industries whose technology and growth we founded and fostered.
h) Daily challenges to our world leadership.
i) Chaos in, and almost demolition of, our capital markets, with the resultant worldwide ripple effects.

U.S. plant and institutional structure have produced industrial products for itself and the world on a "catch up" basis with little competitive pressure to emulate either Japan or Germany.

In the past 10 years the following annual rates of productivity growth (1978 figures) have been attained and are increasing among those to whom we have lost leadership:

Productivity Rates—(1978)

Japan	*10.5%*	France	*6.0%*
Netherlands	*7.5%*	West Germany	*5.8%*
Sweden	*7.1%*	Switzerland	*5.3%*
Belgium	*6.5%*	Canada	*4.3%*
Italy	*6.4%*	United States	*3.4%*

In 1979, the U.S. rate was 0.6% and in 1980 a negative 1.9% This supports (and continues) the alarming accumulative trend from 1970-1977.

Accumulated productivity gains—

Japan	*105%*	
Germany	*66%*	
France	*54%*	
United States	*24%*	(for comparison)

The Council of Economic Advisors suggests it will be a hard struggle to return to 1.5% per year up through 1985.

And all present facts indicate that the next 10 years to 1990 is when the United States productivity really goes back—UNLESS WE BEGIN TO TAKE POSITIVE CORRECTIVE ACTIONS.

Our competitor's productivity rate increase of an anemic 1.5% per year for the U.S. is far from enough. It is, in fact, a blue print for catastrophy. We can no longer afford the luxury of talk and study. The United States is no longer the world's most affluent nation.

So far, our figures indicate how we got to the cliff's edge. If we apply the present trends with no correction, using current rates and trends, other nations will surpass us by 1990, still at a diverging trend with the U.S. At that point, our standard of living will have plunged. We will be an ineffective world economy, military power and almost incapable of turning ourselves around.

If we make the reassuring (but not necessarily true) assumption that the rate of increase of these other nations will stabilize because they will have reached the point of diminishing returns, we must still attain the following rates of productivity growth to even equal them.

Needed growth rates for U.S./year
2.5% (or better) by 1982
3.0% (or better) by 1985
4.0% by 1990

And then, just to maintain parity, we need annually compounded 4.0% GNP net growth.

The distruction of physical plants (instant amortization) in Japan and Germany, because of World War II, not only permitted their rebuilding with new facilities, equipment and technologies, but also created new institutional structures to manage them.

If we apply the present trends with no correction, using current rates and trends, other nations will surpass us by 1990, still at a diverging trend in the U.S.

The new and coordinated institutional structures of Japan have permitted nearly instantaneous marshalling of government, financial, industrial and academic resources to the attainment of consensus national and international goals. Japan chose, largely through MITI, goals of enhanced industrial productivity, foremost international trade and economic position among nations, and then mobilized national resources toward their attainment.

CURRENT ENVIRONMENT

U.S. plant and institutional structure have produced industrial products for itself and the world on a "catch up" basis with little competitive pressure to emulate either Japan or Germany. While institutions of Japan and Germany concentrated on national goals, the U.S. institutions became decentralized and divisive, creating an adversarial climate among government, industry, and academia, thus rendering it almost impossible to set consensus goals and strategic plans to achieve them.

The destruction of physical plant (instant amortization) in Japan and Germany, because of World War II, not only permitted their rebuilding with new facilities, equipment and technologies, but also created new institutional structures to manage them.

In the U.S. environment:

1) The Productivity rate is declining rapidly.
2) Capital formation and investment in productive facilities is declining because financial resources are being removed from the control of the private industry sector. (Corporate taxes have increased from 38% to 48% from 1966-1976.) It is almost impossible for new small entrepreneurial ventures to raise capital and create jobs.
3) Average return on investment has decreased from 10% (1965) to 4% (1977). At a 4% rate of return on productive investment, there are many better places for resources with less risk of capital loss.
4) Rate of technology transfer from generic technology to useful products is declining rapidly.
5) Rate of generation of new, useful technology and innovation is decreasing rapidly.
6) Education of people resources in new technology usage and product application lags badly. Worse yet, education of government, industry, and general public leaders for the acceptance of the important role of new technology for the creation of new industries and new jobs is almost nil.
7) Environmental energy and safety standards have constricted individual initiative and preempted the use of resources from industrial product wealth generation. They have created a regulative climate that severely restricts entrepreneurial initiative based on good, sound, scientific and engineering research and development.
8) Industrial companies are unable to cooperate on fundamental generic application research for fear of possible anti-trust violation, causing duplication of effort and increased product cost.

Since World War II we have generated jobs for a phenomenal number of people (12,800,000) entering the labor market and have, until now, held our unemployment rate low. But this has been based on our absolute productivity lead that supported the primary industrial and secondary service market. However, by 1990, unless we act, this slim advantage will have disappeared. Other industries and employment opportunities will have joined steel, autos, shipping, textiles, photographic equipment, consumer electronics (radios, televisions, etc.), in their abdication to other countries. We will be further pressed by the rapidly increasing resources, education and initiative of the LDC's (Less Developed Countries), as head-to-head competitors for world position.

CORRECTIVE POLICIES

We must take immediate and constructive steps to alleviate, terminate and reverse the decline of U.S. productivity. We should, from a policy and planning standpoint:

1) Accept the fact that we have a serious productivity problem impacting our economic existence.
2) Set goals to:
   a) Reverse productivity decline by a practical yet attainable point in time.
   b) Stabilize our world economic position with constructive international policies and trade goals.
   c) Enhance the utilization of our physical and human resources.
3) Establish strong and aggressive policy initiatives to accomplish our national productivity goals.
4) Encourage R & D on technologies that will result in new products and processes and create new jobs.

We must acknowledge the fact that the "bottom line" of our productivity problem on its present course will be a disaster for the U.S. economic system and standard of living unless we accept the important of technology in regaining world leadership.

We must acknowledge the fact that the "bottom line" of our productivity problem on its present course will be a disaster for the U.S. economic system and standard of living unless we accept the importance of technology in regaining world leadership.

To understand the important role technology plays in increased productivity, we must look at the following figures covering the past 40 years. According to E. Denison of the Brookings Institute, these factors make up productivity:

Technology	38.1%
Capital	25.4%
Labor Quality	14.3%
Economies of Scale	12.7%
Resource Allocation	9.5%

Having highlighted the problem and its general causes, we must now turn to the plan for a solution. In our perception, the above are perhaps the most important figures in this paper. They indicate the points on which we should focus our resources for attack.

Innovative technology in products and processes has been the source of our economic well-being. The Japanese recognized this, copied our technology, applied engineering and management skills in a favorable climate, made heavy capital investment, and took world economic leadership away from the U.S.

To regain that leadership, we must develop innovative technologies and apply heavy doses of capital to create a new and expanded industrial base that will create the solid jobs necessary for our economic well-being.

We must promote quick and effective transfer of leading edge technologies into new products and manufacturing processes.

We must promote quick and effective transfer of leading edge technologies into new products and manufacturing processes by:

a) Encouraging industry and government to invest in applied and new technologies.

b) Setting depreciation schedules that are more compatible with the real world of obsolescence. Grant special tax credits for the added risk involved in accepting and installing new technologies.

c) Changing the patent laws to permit individual innovative entrepreneurs to retain adequate proceeds from their inventive efforts. Transferring dormant technologies from the public sector to useful job creating products and processes in the private sector.

d) Encouraging individual savings and investment.

e) Encouraging, by tax law changes, the formation of small enterprises based on new research and technology (fall off in rate of formation of small firms since tax law changes in 1969 and again in 1976 are almost total).

f) Encouraging development of meaningful interface mechanisms to permit timely in-flow of new foreign technologies to the U.S.

g) Accelerating the development of government policies, legislation, and regulation designed to encourage more effective use of our human resources, through training, education, and recognition of financial support needed for new and evolving skills and technical careers.

h) Streamlining the myriad components of the Government, Executive Branch, Congress, technical and scientific committees, etc., to work more efficiently to identify goals and promote policies leading to the rapid solution of our productivity problem. Terminate endless, time-consuming and self-serving cosmetic debate, and replace it with action and solution-oriented agreement.

i) Directing top management in acceptance of the role of new technologies and committing their enterprises to these applications and uses.

Policy Document No. 2
March, 1981

Robotics Technology— A Major Component in the Solution of the U.S. Productivity Problem

Robot Insitute of America
One SME Drive
P.O. Box 930
Dearborn, Michigan 48128

Limited quantities of this report are available at no cost from: Robot Institute of America ● P.O. Box 930 ● Dearborn, Michigan 48128

The United States has almost lost its productivity lead to its major internal and international competitor—Japan. Continuation of present productivity trends will, in 1990, irreparably damage the U.S. trade position and its standard of living. The U.S. must immediately emulate the Japanese by setting national policies and goals to encourage productivity. Specifically, it must accept, as do the Japanese, technology and robotics as the major tool to increase productivity. It must encourage a climate of cooperation, and change its tax structure to encourage both capital formation and the rapid installation of robotics in U.S. production operations. Its depreciation policies must reflect true obsolescence and deterioration of equipment and permit adequate capital recovery for replacement. Robotics and the innovative technologies should receive special additional tax credits to speed their installation. CONCLUSION—The United states is enjoined in a struggle with Japan for its economic life and standard of living.

Robot Institute of America
Executive Committee:
Stanley J. Polcyn, *President*
Walter K. Wiesel, *Vice President*
Michael Radeke, *Secretary*
Richard G. Abraham, *Treasurer*
John A. Fulmer, *Past President*
Bernard M. Sallot, *Executive Director*

Robotics Technology— A Major Component in the Solution of the U.S. Productivity Problem

Executive Summary

The purpose of this paper is to show how robotic technology can be a major component in reversing the current declining trend of U.S. productivity. A comparison is drawn between how Japan accepts, uses and promotes the technology and what should be done in the U. S. by industry and government. It is not our opinion that we emulate the Japanese but rather learn from them, as they learned from us, and apply, intelligently, the ideas that make sense. It should be recognized that the U.S. is the leader in the development of robotic technology and Japan is the leader in applying and using the technology.

The following is what should be done by industry and government to implement an agressive program to infuse robotic technology in U.S. industry and surpass the Japanese:

INDUSTRY

1) Make the firm decision for large scale incorporation of robotics in the production processes.
2) Assign priority to robotic installation, recognizing it as a form of automation that is one of the quickest and least expensive ways of increasing productivity.
3) Provide supervisory and engineering training that will assist them in understanding the advantages of robots and how to use them and accept the responsibility for participating in the retraining and upgrading of the displaced workforce.

GOVERNMENT

1) Set national policies and goals that will permit rapid modernization of production facilities and the rapid installation of robots by establishing robotics as a major strategic industry.
2) Restructure depreciation schedules so they are more compatible with the real obsolescence of industrial equipment.
3) Immediately match or surpass foreign government incentive programs for robotic infusion.
4) Provide government funds to assist in generic applied research for advancing robotic developments.
5) Provide assistance for the retraining of displaced workers.
6) Change tax laws to encourage capital accumulation, recovery and investment in innovative processes and products.
7) Eliminate the adversary condition between government and industry and set a political climate to encourage cooperation toward national goals.
8) Understand that failure to adopt new technology and invest prodigious amounts of capital in new plants, equipment and processes is a direct roadmap to loss of jobs and plant closings.

Japan Uses Robotics as a Major Economic Weapon

The Robot Institute of America recently issued a background document on the subject of productivity and how it affects the United States' standard of living, inflation, employment, economic soundness, and loss of world export leadership. It covers the history of our productivity deterioration from factors that contributed to the current climate which, after six years of "problem defining and measuring" still leaves us without coherent national policies and goals. And in a broad sense, it lists the areas in which action must be taken. The Institute felt such a document was necessary if all groups in the United States were to have at least an elementary knowledge of the problems they face. Little is said in this document that has not already been said by hundreds of industrialists, economists, executives, government officials and others. Placing all their papers side by side would reveal a remarkable similarity on what the problem is, how it developed, and how to solve it. The consensus that is not revealed is the sorting through of and the will to act in a cohesive, cooperative spirit that would put behind us our last few divisive years.

The Japanese have not been noted for their innovativeness. Rather, they have been excellent emulators. They are basically superb, thorough, and exceedingly energetic engineers. In fact, they have researched and used excellent managerial talents, copying our technology and products, to become our foremost economic adversary. The Robot Institute feels, therefore, that we should look at the things Japan did to achieve superiority and use their successful tactics to regain our leadership. It is now apparent that Japan has passed to an innovative mode from strict emulation. Examination of their strategy and motives reveals that next to strategic planning and national goal setting, adequate and new technology are their major strengths. Within that framework, robotics has emerged as their major weapon.

The Robot Institute of America asks the question, "If Japan Can. . .Why Can't We?" Let's look at what Japan has done:

The Japanese have not been noted for their innovativeness. Rather, they have been excellent emulators.

Japan, like other countries, has inflation. But its causes are different and it has acted quickly and effectively to keep it under control; So far, the U.S. has failed to accomplish this.

The Chase Manhatten Bank Newsletter says, "Japan seems to be winning the battle against inflation." Consumer prices rose only 4.8% in 1979, 7.5% in 1980, and will project an increase of approximately 6.0% for 1981. These figures are parallel with both OPEC prices and OPEC events (war, hostages, etc.). And

while most of Japan's consumer price increase has been due to oil, it has other domestic forces under control largely by massive increases in productivity, strategic cooperative planning, major doses of technology improvement, and capital investment.

"We have prevented imported inflation from becoming domestic home-made inflation"—Isamu Miyazaki, Vice Minister, Japanese Economic Planning Agency.

". . .there currently is very little home-grown inflation here"—Eric Hayden, Tokyo based Vice President, Bank of America. . .99% of it (inflation) is from offshore."

"Japan does not have the wage/price spiral of other countries," states Tsotomu Nishimura, Chief Economist, Sumitomo Bank. (The 1979 wage increase was 6.9%, 7.3% in 1980, and the 1981 forecast by Mr. Miyazaki, Japanese Economic Planning Agency, is 7.9%.)

More importantly, productivity is keeping pace—6% in 1980, considered a good year, and a forecast of 11.0% for 1981. Therefore, unit costs of production have remained relatively stable, accounting partially for the Japanese cost advantage in foreign trade. (Most charges of Japanese dumping turn out to be simply lower costs because of greater productivity.)

Assistant Secretary of Labor under the Carter administration, Arnold Packer, said, "The difference is we have labor leaders who insist on wage increases that far outstrip productivity, and the Japanese don't." According to Yoshihiro Inayama, Chairman, Nippon Steel, "Cost of living increases are not used in Japan, so wages do not rise automatically with price. The countries with the worst inflation are those that link wage increases to price increases."

"We have prevented imported inflation from becoming domestic home-made inflation—Isamu Miyazaki, Vice Minister, Japanese Economic Planning Agency.

Japan has also successfully restricted the growth of its money supply. In 1980, it was only 8.0%. Interestingly, Japan has horrendous national deficits ($67.9 billion in 1980) for a country half the population size of the U.S. The difference is that funds are borrowed from the Japanese people, who save 20% vs. 5% in the U.S., and Japan does not pay its deficits with printing press money. According to Mr. Hayden, Bank of America, in Japan, the people and the government save and in the U.S., the people and the government spend.

What specifically does Japan do to promote the use of technology in solving its inflation, productivity, and world trade problems? First, Japan sets national goals and objectives, combined with consensus and priority as an integral part of the setting, followed by strategic planning for their implementation. Second, Japan takes a specific technology such as robotics (of which the U.S. was the founder and leader) and makes it a prime inclusion in its industrial operations, improving its own productivity and enhancing its world market position for its products. Japan presently has over 7,500 installed robots.

Japan, as a part of its own international and multinational plan, intends to market robots internationally starting with low cost, lower technology robots and working up into the more sophisticated robots as they enter and secure markets. (In late 190, Fujitsu's new plant had a capacity to produce, yearly, more robots than are currently installed in the entire United States.)

Factors in the Japanese culture that promote robot acceptability are:

1. Guaranteed lifetime employment until age 55-60.
2. Payment of semiannual bonus from company, based on productivity and company profitability equal to 2-5 months of the worker's annual salary. Workers have not opposed robotics because its potential for increasing productivity and profitability enhances their bonus.
3. Assumption by Japanese companies of the responsibility for retraining and upgrading the skills of displaced employees.
4. MITI (Ministry of International Trade and Industry) has deliberately identified robot p roduction as a major strategic industry, vital to Japan's national and international trade development. It regards the installation of robots as necessary to offset Japan's scarcity of labor, to reduce job labor content, and to enhance economies of scale in manufacturing.
   MITI has not just talked. It has taken specific actions to implement its robot strategic plan:
   a. With MITI direction, Japan Robot Lease was founded in April, 1980. It is jointly owned, 70% by the company members of the Japan Industrial Robot Association and 30% by ten, non-life insurance companies. The objectives of Japan Robot Lease are to encourage and support robot installation by small and medium size Japanese manufacturing companies, thereby increasing their productivity. Because 60% of operating capital is furnished by government subsidy (Japan Development Bank loans), the leasing conditions will be more advantageous than regular leasing.
   b. MITI has arranged for direct government low-interest loans to small and medium sized industry to encourage robot installation, to automate dangerous processes and to increase productivity. The Small Business Finance Corporation budgeted in February, 1980, 5.8 million yen ($19,000,000 U.S.).
   c. MITI has permitted manufacturers who install robots to depreciate 12.5% of initial purchase price in addition to regular normal depreciation.

"The difference is we have labor leaders who insist on wage increases that far outstrip productivity, and the Japanese don't."

5. The Japanese Industrial Robot Association indicates robot production in 1979 was 36.0 billion yen ($180,000,000 U.S.) and projects 195.0 billion yen ($975,000,000 U.S.) in 1985.[2]
6. Although auto production dominates in the use of robots, robots are well diversified across the industrial spectrum, both in arc and spot welding, painting, materials handling, machine tools and assembly.

JAPAN'S PLANS FOR THE NEXT DECADE

Future Japanese strategic plans call for:

1. Rapid expansion into high volume operations. This will permit quantity production of standard robots that will take advantage of economies of scale both in manufacture and use.
2. Increasing focus on "intelligent" robots which represented 9.9% of sales in the first half of 1980.
3. Increasing focus on development of batch manufacturing technology to permit cheaper product diversification.
4. Targeted generic research in vision and tactile sensing for greater flexibility and expansion of the robot user market.
5. Declaration by MITI that robotics is the technology that will permit Japan to hold its productivity lead.

Fujitsu's new plant had a capacity to produce, yearly, more robots than are currently installed in the entire United States.

WHAT SHOULD THE UNITED STATES DO?

Industry

1. Complete its feasibility studies and make the firm decision for large scale incorporation of robotics into its production processes.
2. Make large and long term commitment to the acceptance and inclusion of robotics. This will permit U.S. manufacturers to expand their manufacturing capability to suppiy the needs of U.S. industry and prevent the incursion of Japan into U.S. markets.
3. Accept the responsibility for retraining and upgrading its work force when displaced by or when augmenting robot usage.
4. Assign priority to the installation of robots, recognizing that robots are one of the quickest and cheapest ways to increase productivity.
5. Cooperate with worker groups to assist them in understanding the advantages of robots and accept them more easily. Assign priority of installation to dull, dirty, dangerous jobs. Work out plans to share the benefits of increased productivity. Emphasize that we must have the long term advantages of robot technology, but that they will not happen without near term dislocation of work force, some rather severe.

Government

1. Set national policies and goals that will permit rapid modernization of production facilities and the rapid installation of robots. Establish robotic production as a major strategic industry.
2. Structuring depreciation schedules that are more compatible with the real obsolescence of industrial equipment. Permit rapid write-off for more certain capital recovery.
3. Immediately match (or surpass) foreign government incentive programs for robot usage.

4. Encourage deployment by the Department of Commerce of some of the resources and authority of the Stevenson-Wydler Technology Innovation Act of 1980 to support generic research for tactile and visual sensing for advancing precision robotic developments suitable in a wide range of industrial processes.
5. Provide assistance for the retraining of displaced workers, including attention to our nation's public education system which reflects an appalling lack of basic math and science training required to upgrade unskilled workers for participation in more advanced industrial production processes.
6. Immediately change the tax laws to encourage capital accumulation, recovery, and investment in innovative processes and products.
7. Take immediate steps to eliminate the adversary condition between government and industry, and set a political climate to encourage cooperation toward national goals.
8. Understand that failure to adopt new technologies and invest large amounts of capital in new plants, equipment and processes is a direct roadmap to plant closings and loss of jobs. Technology (38%) and capital investment (25%) equate to over 63% of the driving force that creates new industries and jobs.

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THE NATIONAL ROLE AND IMPORTANCE OF MANUFACTURING ENGINEERING AND ADVANCED MANUFACTURING TECHNOLOGY

Position Paper by:
Society of Manufacturing Engineers'
Government Relations Committee

Approved by the SME Board of Directors
May 8, 1978

SOCIETY OF MANUFACTURING ENGINEERS

Exhibit A

The National Role and Importance of Manufacturing Engineering and Advanced Manufacturing Technology

The Society of Manufacturing Engineers recommends a national commitment to the improvement of productivity through advanced manufacturing technology. The urgency of this recommendation cannot be overstated. Nor can the consequences of our failure to act be ignored without endangering the national economy and the ultimate welfare of the nation. Suggestions as to an appropriate course of action are contained in this paper and in the attached enclosure.

The Analogy of Agriculture. Since its founding more than 200 years ago, the United States has evolved from an agrarian into an urban culture. In 1776, more than 90 percent of the population was involved in agriculture. Today less than 5 percent of the population is associated with agriculture. Despite this decline in numbers, Americans today have a higher per-capita consumption of food than at any time in the nation's history. Further, the variety of foods has increased, and the levels of food stocks exported have risen exponentially. Despite our greater consumption of food and our increasing exports, the abundance is such that the modern farmer must be subsidized as a way of curtailing the amount of land farmed and the size of the crops obtained.

The resounding success of American agriculture begs a question: Can this success be duplicated in industry? The answer, we believe, is yes. This answer derives from an examination of the history of agriculture, a few highlights of which can be briefly summarized as follows:

In 1862 the federal government established the Department of Agriculture. By the Merrill Act--enacted that same year--the federal government established the land-grant college system. This system has, for more than a century, trained countless numbers of young men and women in advanced agriculture technology.

The land-grant colleges also have large experimental stations which conduct important research in agricultural methods and processes. Importantly, the colleges also train government personnel in the latest findings. The government personnel then update the farmers through personal contact and published reports.

Thus the federal government has established a highly effective system through which it continually searches out higher-productivity agricultural methodologies which are then relayed to the actual practitioners in the field. It is a system that has increased the productivity of American agriculture to a point where it is the envy--and the wonder--of the rest of the world.

Application to Industry. The American industrial system, although still the most powerful in the world, is beset with problems which could in the end prove fatal. It is the contention of the Society of Manufacturing Engineers that this malaise can be corrected through the development and utilization of a system similar to the agricultural system previously described. Accordingly, the Society recommends the following:

The National Role and Importance of Manufacturing Engineering and Advanced Manufacturing Technology

The economic health and well-being of an industrial nation goes hand-in-hand with the health and well-being of its manufacturing industries. This is so for two excellent reasons, the first of which is that manufacturing accounts for approximately one-third of the gross national product (GNP) of such nations.

Secondly, manufacturing is the principal wealth-producing activity of modern industrialized nations. Services account for approximately one-half of the gross national product of most industrialized nations, but services are not wealth-producing activities. They depend for their support on the wealth-producers, i.e., the extractive (agriculture and mining) industries, the construction industry, and the manufacturing industry. It can be shown without difficulty that manufacturing accounts for approximately two-thirds of the wealth produced in modern industrial nations.

A Statistical Breakdown. In the case of the United States, the latest available statistics--those for 1974--show that manufacturing accounts for approximately 23 percent of the GNP. The extractive and construction industries account for about 11 percent and services for the remaining 66 percent. From this it follows that manufacturing accounts for about 68 percent of the direct wealth-producing activity of modern America.

Advanced Capabilities--Greater Requirements. The health of a nation's manufacturing industry is measured by its ability to survive and to compete with other nations in the marketplace--its own and the world's. The primary determinant of its health is the quality and sophistication of its manufacturing technology. In amplifying upon this statement, two factors are of paramount importance:

- The Computer. Originally designed for computational and clerical purposes, the digital computer has moved into a position of dominance in modern manufacturing. It is the sine qua non of all manufacturing systems in which automation, control, and optimization of hardware and software are considerations. It can be said that the sophistication of a manufacturing system is directly proportional to its effectiveness in utilizing computer technology.

- Economic and Social Pressures. Powerful economic and social pressures have come to bear on manufacturing in the past decade. For the most part, these pressures are associated with productivity and the growing reluctance of people to work in the manufacturing industry.

Productivity. The decline in manufacturing productivity is a world-wide phenomenon. To assess its impact on the American economy and the economy of the free world in general, the Society of Manufacturing Engineers has studied the productivity and costs statistics for ten Western nations: Belgium, Canada, France, West Germany, Italy, the Netherlands, Sweden, Switzerland, the United Kingdom and the United States. Also studied were the same figures for Japan. These figures are both enlightening and shocking. For example:

1965 to 1970. During this period, manufacturing productivity, as measured in output per man-hour, increased at an average annual rate of 6 percent. But manufacturing labor costs, as measured in compensation per man-hour, increased at an average annual rate of 9 percent.

This is an unhealth situation because a negative differential between productivity and labor costs unleashes powerful inflationary forces. But let us now look at the subsequent five years:

1970 to 1975. Manufacturing productivity rose at an average annual rate of only 4.5 percent. Manufacturing costs rose at an annual average rate of nearly 21 percent.

And thus we come to the roots of the inflation that has plagued the Western Bloc nations and Japan for the past fifteen years. But before prescribing a cure, let us examine the statistics for the United States alone:

1965 to 1970. Manufacturing productivity increased at an annual rate of 2.1 percent. Manufacturing labor costs increased at an average annual rate of 6.0 percent.

1970 to 1975. Manufacturing productivity increased at an average rate of 2.0 percent. Manufacturing labor costs increased at an average annual rate of 9.5 percent.

The implications of these figures lead to a single conclusion: That manufacturing costs must be reduced through the increased application of advanced manufacturing technology.

A Proven Concept. The development and application of advanced manufacturing technology has demonstrated its capability to reverse this otherwise disastrous national and international trend. In the field of metalworking manufacturing, prototype computer controlled manufacturing systems are operating on a semi-experimental basis in Japan, West Germany, and the United States. These systems have demonstrated an ability to increase the productivity of batch type parts-making by several hundred percent. Similarly, they have demonstrated their ability to reduce labor costs in such operations by 80 percent and more.

Social Pressures. In most industrialized nations, the percentage of the workforce that is willing to work in manufacturing jobs is constantly shrinking. In the United States the trend has been clearly downward since the end of the Second World War. Professor Daniel Bell of Harvard, who has been studying this trend, cites some interesting and informative statistics on this subject in his book The Coming of the Post Industrial Society.

In the period 1968-1980 Prof. Bell sees the total available workforce in the United States expanding by some 23 percent. The service-producing activities are expected to increase by approximately 31 percent. But the goods-producing activities (the manufacturing industry) will increase by only 9 percent.

Looking backward to the beginning of the trend, in 1947, 30 percent of the workforce in the United States was employed in manufacturing. By 1968 the percentage figure had dropped to 24.9. The Bureau of Labor predicts a dropoff of 22.4 percent by 1980. And Prof. Bell predicts that it will be down to 10 percent by the year 2000.

But it is imperative that the manufacturing industry continue to grow throughout this period, since it is the principal wealth-producing activity of the country. And because the migratory drift of workers away from manufacturing and into the services sector is apparently irreversible, new manufacturing methodologies must be employed. These methodologies will provide an even greater flow of manufactured goods; they will sustain this flow with far fewer people. They will involve computerized systems that are almost completely automated.

The Digital Computer. It is said that the introduction of the digital computer heralded the advent of a new revolution in manufacturing. It is more likely that the entry of the computer to manufacturing marks the beginning of the ultimate and final phase of the Industrial Revolution. These points of view represent philosophical differences that will be resolved by scholars as yet unborn. For our purposes it suffices that the digital computer provides the wherewithal to solve the principal problems outlined in this paper: declining productivity and the growing distaste of people for work in manufacturing systems.

To measure the impact of the computer on manufacturing, and to develop statistically valid data concerning its future impact, the Society of Manufacturing Engineers, in cooperation with The University of Michigan and the National Machine Tool Builders Association, has undertaken a number of Delphi* studies. The first study, published in May, 1977, included the following points in its forecast:

1. By about 1982, approximately 10 percent of the total machine tool production will be used in integrated, computer-controlled manufacturing systems. These systems will be equipped with automated parts handling equipment for workpiece movement through the system. Like the machine tools, the material handling equipment will be under the control of a central computer.

2. By about 1985, computer software systems for the automation and optimization of all steps in manufacturing planning will be used by at least 25 percent of the manufacturing industry. These steps include the development of machining sequences, the selection of the necessary machine tools, clamping, the selection of operational sequences, tool selection, the selection of optimum cutting conditions, and the like.

3. By about 1987, approximately 38 percent of the total manufacturing systems will be equipped with diagnostic sensors and the associated software for detecting and correcting breakdowns in the system.

*Delphi forecasting is a statistically valid methodology for predicting future events on the basis of current trends. The methodology was developed by the Rand Corporation to answer certain questions related to the national security. Rand's development and subsequent use of Delphi forecasting provided satisfactory answers. Rand's naming of the process for the classical oracle of Delphi must be regarded as classical whimsy.

These points and numerous others made in the Delphi study underscore the fact that the computerization of industry will become an irreversible fact of life before the end of the century. Before this happens, however, certain changes in our approach to the related research and development are mandatory.

A Cooperative Endeavor. Many nations have recognized the two inevitable facts concerning computerized manufacturing. The first is that they must develop systems of the type discussed in this report if they are to survive as world powers. The second fact is that the development of such systems calls for cooperative effort on a national scale. A number of such efforts are now being implemented throughout the world. These efforts are all-inclusive in that they involve cooperative action by the manufacturing industry, universities, government, trade associations and technical societies related to, or affiliated with, the manufacturing industry.

The Japanese Effort. The example provided by Japan is worthy of study and possibly of emulation. Japan has made the development of computerized manufacturing a national program in which work is divided among the following:

1. Universities. Basic research in a multitude of small projects. Average funding: $30,000 each.

2. Government Laboratories. Applied research in a variety of medium sized projects. Average funding: $300,000 per project.

3. Industrial Companies. Development in a limited number of large projects jointly funded by government and industry. Average funding: $3 million.

The background study, planning and coordination of this work is accomplished through a number of committees. The structures of these committees include representatives from industry, the universities and government. The related organizational and administrative work is accomplished through appropriate trade associations and technical societies. Government and industry share in the necessary funding.

One especially noteworthy result of the Japanese approach is the recent planning of a national program called "Methodology for Unmanned Manufacturing." The purpose of this program is to develop and implement a number of computer-automated and optimized manufacturing plants. The first step in this program is to be the development of a small prototype, scheduled for operation by 1984. The Ministry of International Trade and Industry has contributed $50 million to the funding of this effort, thus giving a testimonial of sorts to the seriousness of the Japanese effort.

Other nations are developing cooperative programs similar to Japan's. The most significant to date are now aborning in West Germany, Norway, East Germany, Czechoslovakia and the Soviet Union.

The Abortive American Effort. Similar attempts to develop a cooperative approach to the automated factory have not fared so well in the United States. A small

amount of basic research was being funded by the National Science Foundation. But even this effort, which was small compared to that of our overseas competitors, suffered a serious setback with the dismemberment of the RANN Division of NSF. For it was RANN that provided the necessary support.

Two other items tend to support the contention that there is little or no interest on the part of the federal government in computer-aided and computer-optimized manufacturing. One is the budget cutback for the newly launched Air Force/DOD program on Integrated Computer Aided Manufacturing. Importantly, this cutback came in the program's first full year of operation.

The other item is the fact that the excellent report of the Comptroller General of the United States to the Congress has received virtually no response from that body. And yet the report entitled Manufacturing Technology--A Changing Challenge to Improved Productivity, defines the problem and its consequences in devastating detail.

The Needed American Effort. The wealth-producing function of manufacturing is fundamental to the economic well-being of America. It is an area of human endeavor in which we have been dominant for several generations and one in which our still formidable capabilities have given us a flow of material goods unprecedented in world history. It is an area in which we have functioned superlatively well without government support but with government intervention--much of it unnecessary.

But now the rules of the game are changing, largely because of the growing complexity of technology and the speed with which it is evolving. There was a day--not long ago--when each intelligently managed industry could easily assimilate change and make the necessary adaptations.

But the continuing and rapidly accelerating evolution of industry has now brought us to the gates of the automatic factory. To step inside calls for a greater effort than any one industry can make on its own. We can proceed no further without a cooperative effort in which industry, academia, the federal government and the technical societies join hands--as is now being done in Japan, Norway and West Germany.

The alternative? The rapid decay of American industry and the degeneration of America itself into a small and unimportant industrial backwater. It is an alternative that we need not--and cannot--contemplate.

COOPERATIVE TECHNOLOGY--AN ACTION ALTERNATIVE FOR PRODUCTIVITY ADVANCEMENT

Position Paper by:
The Society of Manufacturing Engineers

Approved by the SME Board of Directors
April 30, 1979

COOPERATIVE TECHNOLOGY--AN ACTION ALTERNATIVE FOR PRODUCTIVITY ADVANCEMENT

On May 8, 1978, the Board of Directors of the Society of Manufacturing Engineers (SME) issued a position paper entitled "The National Role and Importance of Manufacturing Engineering and Advanced Manufacturing Technology." This paper confirmed and reinforced the conclusions drawn in earlier studies conducted by the U.S. General Accounting Office. In so doing, it underscored the urgent need for a national commitment to productivity improvement through advanced manufacturing technology. The SME paper also recommended the strengthening of existing federal programs designed to alleviate the problem of declining productivity.

The position taken by SME in this paper was--and is--strongly supported by other technical societies and associations, and by acknowledged authorities on the productivity crisis. It is noteworthy that the SME paper was extensively quoted by the National Center for Productivity and Quality of Working Life in its final report, entitled "Productivity in the Changing World of the 1980's."

A strong--indeed, an undeniable--consensus has emerged. The consensus is that federal support, in one form or another, must be forthcoming if American scientific and technical superiority is to be restored. Further, this scientific and technical superiority is an imperative if the nation is to attain the ancillary benefits of economic growth, an improved competitive posture in the world marketplace, and the technological capabilities necessary to an impregnable national defense.

The consensus is manifest. A consensus as to how government can best be involved is far less explicit. There are two strongly supported alternatives worth noting, however. They are as follows:

- Direct Participation. Federal assistance in technological advance would be given through the funding of basic research through government procurement policies, through stimulation of innovative enterprises, and through assistance in technology transfer and manpower training for low-growth industries.

- Economic Policy. Federal assistance would be given through a national economic policy designed to amplify the incentives and funding for expanded research and development. Included in this policy would be inflation control, tax credits, reduced regulatory constraints, and modification of antitrust and patent policies.

It is the contention of SME that these interrelated problems in productivity and innovation--as well as many of the alternatives for corrective action--have been well identified by industry for nearly a decade. However, the more recent inquiries and investigations have served (1) to clarify the need to coordinate technological advance with national social and economic goals, (2) to identify the industry segments that are not competitive in world markets, and (3) to identify blockages requiring federal policy adjustments.

Additional byproducts of these investigative efforts by Congress, the Department of Commerce, the General Accounting Office, the National Center for Productivity, and the Office of Technology Assessment have been the generation of relevant statistical data, coordinating techniques, and the development of people-skills essential to a continuing federal involvement in this crucial issue.

The present need--and it is a need of utmost urgency--is to establish an organizational mechanism to implement and apply these findings to a positive program for corrective action.

In its 1978 productivity position paper, SME suggested a restructuring of the Department of Commerce. It further suggested that the restructured department could serve as a focal point for affirmative action in implementing the position paper's advanced manufacturing technology program recommendations.

The Society has been encouraged by the Secretary of Commerce's formation of an Industrial Innovation Coordinating Committee charged with responsibility for the development of specific federal policy recommendations. This initiative has also generated a proposal for a Cooperative Technology consortium in which private enterprise, government, and universities would focus on fundamental technologies which underlie a wide range of industrial needs.

The Cooperative Technology Program*, to be administered by the Assistant Secretary of Commerce for Science and Technology, is a positive and potentially meaningful concept aimed at the improvement of industrial productivity. As presently perceived, the Cooperative Technology concept will stimulate action with respect to industry-identified technical needs related to basic or applied research. This research would be in areas of major national interest which are not adequately addressed by the private sector because of industry fragmentation or a lack of market incentive.

Through the Cooperative Technology concept, the government would support, but not totally fund, technical needs which have been identified by industry. These needs would usually be met by applied research carried out at university centers. There are a number of reasons why SME feels that this program should be supported:

1. By requiring cooperation as the basis for continuation, it represents a step toward reducing the adversary relationship between government and industry.

2. The government role in the program is the appropriate one of facilitating private sector efforts. The government acts as a catalyst, but industry provides the financial support.

3. The program provides recognition that productivity improvement is an important national goal.

4. The program recognizes that technological innovation is important to the improvement of productivity.

5. The program will act to strengthen the relationship between industry and the university community.

The Society of Manufacturing Engineers has an established history of contributory involvement in productivity, technological innovation, technology transfer, and cooperative technology in the many fields of manufacturing.** On the basis of this experience, the Society is highly supportive of both actions initiated by the Department of Commerce.

Accordingly, SME recommends the passage of satisfactory enabling legislation and encourages a strong national commitment to the new Cooperative Technology concept and organizational approach. SME feels that this form of Federal support of industrial technology advancement would reduce the adversial relationship that exists between government and industry, would provide a catalyst for action to improve productivity through technical innovation, and would strengthen the relationship between industry and the academic community.

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* Appendix A--"Cooperative Technology and the Society of Manufacturing Engineers" describes the Cooperative Technology Program as it relates to SME's sphere of interest and responsibility.

** Appendix B--"Productivity and the Society of Manufacturing Engineers" outlines SME's historical role and contributions to manufacturing productivity.

COOPERATIVE TECHNOLOGY--AN ACTION ALTERNATIVE FOR PRODUCTIVITY ADVANCEMENT

COOPERATIVE TECHNOLOGY AND THE SOCIETY OF MANUFACTURING ENGINEERS

The application of "cooperative technology activities" to assist or enhance specific industries or to generate new technology to meet specific national goals, does not represent a new Federal experience. It has been, and is being, effectively utilized in many programs within the Departments of Agriculture, Energy, Interior, Defense and Commerce, as well as other independent agencies.

The Manufacturing Technology Program within the Department of Defense is an example most familiar to SME. This program is specifically geared to insure economical and reliable production of defense materials through development of improved manufacturing processes, materials and equipment. SME's thrust is to broadly interpret and apply any major advances in manufacturing technology to the benefit of the private sector.

The National Science Foundation, through which much of the basic research expenditures of the government are channeled, is investing an increasing share of its resources in experimental programs for the application of fundamental science to industry problem-solving through cooperative technology mechanisms.

These programs have not been visibly oriented toward the productivity issue, however. Nor has the traditional governmental approach of investing in basic research, with the expectation that market forces alone will insure productive application, proven sufficient.

In its major role as a medium for technology transfer, the Society finds the greater need to be a new force to more rapidly accelerate the rate of implementation of existing technology in critical areas of the manufacturing sector.

A determination to effectively fill this critical void is clearly evidenced in planning efforts recently initiated by the Office of Science and Technology of the U.S. Department of Commerce. This is reflected in the stated objective of their Cooperative Technology Program:

> ". . . to spur production and accumulation of scientific and technical knowledge essential for industrial investment in the commercial development of critical technologies."

The mechanism for accomplishing this objective is fully compatible with the SME's 1978 position paper on productivity. The Cooperative Technology Program would:

- Increase the leverage of industrial funds by pooling resources to find solutions to common problems.
- Increase R & D funds to the critical level required for broad applicability to industry.
- Increase the capability of universities and technical institutes to support the effective utilization of technology in industry.

The planned mode of operation through Cooperative Technology Centers--industry-controlled but jointly-funded by industry and government--should insure work programs responsive to timely and real commercial needs. Properly executed, this program also has potential for a corrective contribution to an ailing national research and development environment.

Administration of the program, through an expanded function of the National Bureau of Standards, will provide a starting credibility, a multidisciplinary perspective, and a focal point for integration with other related government programs.

The Department of Commerce has already initiated case studies in several technologies being considered for Cooperative Technology Programs. These preliminary studies are being carried out to test industry response, identify current needs and to make cost benefit determinations. These include, among others: (1) welding; (2) industrial coatings; (3) computer aided design; (4) powder metallurgy; (5) semiconductor fabrication; (6) flexible manufacturing; (7) corrosion protection; (8) radiation processing; and (9) composites. All of these are considered to be of significant interest to SME or SME-affiliated societies.

CONCLUSIONS

The Cooperative Technology Program currently under development by the Department of Commerce is perceived as a viable action response to the expressed needs for Federal assistance in the innovation process. Successful implementation, with a stable long-term commitment to the plan concepts, should provide a significant new resource to combat the declining trend of national productivity. The proposed Cooperative Technology Program is fully compatible with, and should reinforce, the current programs and longer-range interests and strategies of the Society of Manufacturing Engineers.

This position recommendation carries with it an implied commitment for continuing application of the Society's resources to this common national purpose, in cooperation with this new medium of implementation. Support by SME is based on the conviction of urgency and need for constructive, as opposed to further investigative, action. The many impediments which must be minimized or eliminated to make this program truly effective, are fully recognized.

In the formative stages of the proposed Cooperative Technology Program, the Society will establish and maintain a close line of communication with the Office of Science and Technology. A diligent effort will be made to assist in their organizing efforts by offering technical expertise and the experience of our organization and membership in project planning and administration.

The short-term goal of this preliminary activity, to be controlled by the SME Technical Council, will be the selection of project alternatives related to the advanced manufacturing engineering needs which most satisfactorily meet federal, industry, and Society criteria.

COOPERATIVE TECHNOLOGY--AN ACTION ALTERNATIVE FOR PRODUCTIVITY ADVANCEMENT

PRODUCTIVITY AND THE SOCIETY OF MANUFACTURING ENGINEERS

THE SOCIETY PROFILE

The Society of Manufacturing Engineers is a professional technical society dedicated to advancing manufacturing technology through the continuing education of manufacturing engineers and managers. The specific goal of the Society is "to advance scientific knowledge in the field of manufacturing engineering and to apply its resources to research, writing, publishing, and disseminating information."

The Society was founded in 1932 as the American Society of Tool Engineers. From 1960 to 1969, it was known as the American Society of Tool and Manufacturing Engineers; in January 1970 it became the Society of Manufacturing Engineers.

The changes in name reflect the evolution of the manufacturing engineering profession, and the growth and increasing sophistication of a technical society that has gained an international reputation for being the most knowledgeable and progressive voice in the field.

The principal on-going activities of the Society include:

- Conferences and Expositions. Engineering conferences and expositions represent the most effective mediums for technology transfer. During 1978, 16 expositions and 32 conferences were held with total attendance exceeding 128,000.

- Educational Programs. 1978 educational activities included 65 three-day programs (clinics, seminars, workshops) devoted to a single subject, with technical paper presentations, problem-solving sessions and plant tours.

  The Society also offers academic course materials on all aspects of manufacturing for individual study or group instruction. These include programmed learning courses, home study courses, correspondence courses, and video-tape training programs.

- Publications. The principal periodical of the Society is MANUFACTURING ENGINEERING, published monthly and directed to the entire manufacturing community. A wide range of other publications deals more specifically with specialties within the broad spectrum of manufacturing engineering. These include the Tool and Manufacturing Engineers Handbook, Robotics Today, and the Manufacturing Data Series, consisting of 24 reference books on specific subjects within manufacturing engineering.

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- Technical Divisions. SME's function is to follow and assess the trends and developments in manufacturing; then to interpret, publish and distribute the information. To tap the technical talents of its 50,000 members, SME sponsors 13 Technical Divisions. These are subdivided into 70 technical areas and encompass all of the disciplines of engineering and management in manufacturing. More than 1,000 volunteers contribute their time and talent to provide the technical input for SME's educational programs.

- Associations of SME. To serve the widening technical interests of manufacturing engineers, SME also has created, and serves as headquarters for, several other associations or technical societies. These include the Robot Institute of America (RIA), the Association for Finishing Processes (AFP/SME), the Association of American CIRP Industrial Sponsors (AACIS), and the Computer and Automated Systems Association (CASA/SME).

- Research and Educational Grants. In addition to sponsoring more than 80 student chapters, covering more than 4,000 students at universities and colleges throughout the United States, the Society supports a program of research and educational grants. Its purpose is to promote the development of manufacturing engineering curricula in colleges and universities, to help upgrade the level of instruction where such programs already exist, and to attract an even higher caliber of students to the profession.

  Since 1954, the Society has spent more than a half million dollars to sponsor research and provide capital equipment to educational institutions and to assist in the development of educational curricula.

- Standards. The Society works closely and continuously with the American National Standards Institute, the International Standards Organization, the American National Metric Council, and other national and international organizations. Its purpose is to help establish and maintain the highest possible standards in the field of manufacturing engineering for the benefit of industry and the profession.

  Among the many other organizations with which SME is affiliated are the Association for Cooperation in Engineering, the Engineers Joint Council, the National Council of Engineering Examiners, the American Automatic Controls Council, and the Federation of Materials Societies.

- Certification. Through its Manufacturing Engineering Certification Institute, the Society also certifies Manufacturing Engineers and Technologists for their technical expertise and knowledge acquired through on-the-job experience and informal education. Degreed personnel and registered professional engineers also may become Certified under this program, which was developed with the guidance and endorsement of industry.

THE SOCIETY AND PRODUCTIVITY

The constituency of the Society is primarily engineering professionals and technologists engaged in the manufacture of primary metal products, machinery, electric and electronic equipment, and miscellaneous manufactured products.

Historically, the Society has provided a forum for the expression of concern on various aspects of its members' job environments. Of special importance are the factors that limit growth and the achievement of personal goals. In the late 1960's, an awareness of a diminishing impact of their efforts and dedication to productivity improvement emerged from this forum. The causes, not then fully identified, were believed to be related to factors beyond either individual or management control.

The first responsive action to these concerns led to SME co-sponsorship with the National Science Foundation and the National Bureau of Standards of a "Manufacturing Productivity Conference" in October, 1972. A primary result of this conference was the aggressive application of Society resources to the clarification of problems and the assessment of alternatives for constructive action. Some of the more significant events and actions which occurred as a result of this thrust are as follows:

- Cooperation with the U.S. General Accounting Office in the development of information for their study on "Manufacturing Technology--A Changing Challenge to Improved Productivity." This was further extended to interpretation and dissemination of the study results and conclusions most relevant to the interests of the SME constituency.

- Cooperation with the National Center for Productivity and Quality of Working Life in their continuing efforts to focus public awareness on productivity problems and the influence of federal policies on productivity.

- Active participation in the Department of Defense sponsored Manufacturing Technology Advisory Group Conferences, recognizing that the prime determinant of the strength of our tri-services defense capabilities is highly dependent on the degree of advancement of manufacturing technology.

- Active participation in the Air Force Integrated Computer-Aided Manufacturing Program aimed at the technology required to reduce the metalworking manufacturing process to total automation from initial design to finished product.

- Active support of the robot industry and university institutes in pioneering efforts in promotion of advanced robotic technology. Since 1974, SME has co-sponsored an International Symposium on Industrial Robots on an annual basis.

These participating activities reflect a continuing SME effort to integrate and coordinate government, university, and private industry resources in the development and application of advanced manufacturing systems. They continue to

demonstrate the fact that the basic technology, spawned in the massive atomic energy, space, and communication systems investments, are not approaching their potential for optimization and versatile automation of our factories.

A further consequence of this realization has been the internal restructuring of the Society's organization and programming emphasis. These changes have included the following:

- The annual organization and implementation of a comprehensive conference and exposition on Computer Aided Design and Manufacturing (CAD/CAM) since 1972.
- North American Industrial Robot Conference during the years when international conferences are held abroad.
- The formation and incorporation of the Robot Institute of America to strengthen and support robot technology and its application in industry.
- The organization of a new affiliated Computer and Automated Systems Association (CASA/SME) in 1976 to provide a forum for technical dialogue between a variety of engineering disciplines and to serve as an educational vehicle for its membership.
- The formation and incorporation of an Association of American CIRP Industrial Sponsors to provide an independent medium for interchange of research needs and ideas, international technology transfer, and sponsorship of joint research on broad aspects of production engineering.
- The organization and implementation of annual AUTOFACT Conferences and Expositions. These events recognize the ultimate need for integration of the many engineering technologies in robotics, computer applications, numerical control, and automation essential to attainment of the highest productivity goals. It addresses the future needs of an all-encompassing advanced manufacturing technology.
- The formation of an affiliated Association for Finishing Processes (AFP/SME). This new organization was organized specifically to address emerging problems in development or adaptation of finishing systems to comply with volatile emission control, energy conservation, and toxic material handling regulations. It has provided the principal forum for technical information exchange since 1972 with major conferences and seminars on powder coating, radiation curing, water-borne and high solids coatings, and pretreatment technologies.

Stimulation, reinforcement and amplification of these accelerated efforts has been obtained by contracting for independent studies and surveys by established agencies. The first of these, entitled The Manufacturing Engineer--Today and Tomorrow, was conducted by A. D. Little in July, 1968. The principal motivation was the need for forecasting future educational needs, although its strongly signaled the technological changes we are now addressing.

A recent update entitled The Manufacturing Engineer--Past, Present and Future, conducted by Battelle Laboratories in May, 1979, reaffirms and more clearly defines the technological changes occurring in manufacturing while emphasizing the need for educational adaptation.

The Delphi techniques for technological forecasting were applied by the University of Michigan in major studies of the direction of technological change in four areas of specific interest to the Society constituency. These include:

Manufacturing Systems and Material Removal	May 1977
Manufacturing Management and Assembly	May, 1978
Quality Assurance	In process
Computer Aided Manufacturing	In process

CONCLUSIONS

This itemization of SME's expanding involvement in the promotion and application of advanced manufacturing technology reflects the body of thought now emerging as a national awareness. This decade of Society experience represents countless hours of valuable voluntary effort and contributions by engineers and technologists with personal dedication to professional and technological advancement.

It is significant that their independent rationalizations, as reflected in these activities, now converge with the observations and conclusions of industrial leaders, economists, and political planners.

Society efforts to stimulate innovation, to promote the application of advanced technology, and to break down communications barriers among engineers, industry, government, and educational institutions have made modest progress with limited financial resources. Even more significantly, the process has generated broad lines of communication, a credibility and competence base, and an understanding of the implementation problems to effectively contribute to an accelerated national productivity improvement program.

PRELIMINARY STATEMENT

PRODUCTIVITY IN THE U.S. --

ITS HISTORY, CURRENT PROBLEMS, AND SUGGESTED REMEDIES

PREPARED BY THE SOCIETY OF MANUFACTURING ENGINEERS FOR DISCUSSION AND USE IN PLATFORM STATEMENTS OF THE REPUBLICAN AND DEMOCRATIC PARTIES

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DIRECTOR
PROFESSIONAL AND GOVERNMENTAL ACTIVITIES

APRIL 14, 1980

PRODUCTIVITY IN THE U.S. --

Its History, Current Problems, and

Suggested Remedies

The Productivity Problem

In absolute terms, the United States still leads the rest of the industrialized world in productivity. In terms of productivity growth -- an extremely important economic measuring tool -- the United States now lags all other industrialized nations.

The importance of productivity growth cannot be overstated. It is a contributor to, and an indicator of, the effective annual net growth of the Gross National Product. If we are to make increasingly severe demands on the GNP -- in terms of wage and salary improvements, a growing fixed burden of Social Security, an adequate national defense, the growing cost of environmentalism, and the creation of job opportunity -- it follows that the effective real GNP must have at least a corresponding growth to offset their costs. Otherwise, we will be unable to maintain our present standard of living and fail to regain our worldwide competitive position.

This paper will briefly overview the historical record of the United States with respect to productivity growth. It will then look at problem areas contributing to lack of investment capital, diminished research and development, excessive regulation, conflicting taxation, anti-trust policies, and ineffective technology transfer. Finally, it will comment on the counterproductive effect of the adversarial institutional relationship in the United States. It is hoped that the points raised will be useful guides toward corrective action.

Paramount throughout will be the underlying philosophy that only through the efficient creation of agricultural and industrial products can we have the means to maintain our standard of living and world competitive position and be able to distribute wealth for the benefit of the less fortunate in the United States, and the rest of the world. We believe that this country can no longer afford to delay the acceptance of the productivity challenge. What may have been dismissed as an unfortunate aberration in economic cycles 5-10 years ago, has become a persistent signal that cannot be further ignored if we wish to have a strong economy and a prosperous nation.

Most critically, we need to designate the improvement of productivity as a priority national goal. This will focus the industrial, legislative, academic and public groups on a positive approach that will generate constructive policies, actions, and behavior. We have spent an incredible amount of personal energies and resources in "precise" definition of the problem, attempts to "precisely" measure it, and to seek "precise" solutions amid profuse and voluminous lamentation over our plight.

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Predictably, this has resulted in a climate dominated by policies of restraint, prohibition, regulation, controls, and adversarial litigation as piecemeal solutions to the fundamental problem.

We submit, that the time has come to cease "defining the problem" and adopt positive policies and approaches to achieve its solution.

Background

Following World War II, and prior to the current period, inflation and lack of a continually increasing standard of living was seldom a problem, because our "productivity" always outdistanced inflation and permitted large increases in our standard of living. The years since World War II generated the fantastic and never before achieved yearly average growth of 3.2%. But it has taken us a mere 12 years (since 1967) to fall to a yearly gain of less than 1/2 of 1% (1979) -- and since last year (12 months) it has become negative.

Exactly paralleling this 10 year period, we have seen:

a) Accelerated inflation (18% annual rate)

b) Decreased living standards

c) Declining capital formation and investment

d) Catastrophic negative trade balances

e) Need for continually increasing government transfer payments made from a declining pool of industrial and agricultural wealth.

f) Loss of historical competitive markets causing increased dependence on military rather than economic power to maintain a world leadership position.

g) Forced abdication of leadership positions in basic industries whose technology and growth we fathered and fostered.

h) Daily challenges to our world leadership

i) Chaos in and almost demolition of our capital markets, with the resultant worldwide ripple effects.

In the past 10 years, the following rates of productivity improvement have been attained among those to whom we have lost leadership:

Japan -- 105%

Germany -- 66%

France -- 54%

(U.S. -- 24%) for comparison

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Graphing these figures, at current rates and trends (U.S. decline, others improve), the above 3 nations will equal or surpass the United States in absolute growth by 1990.

Current targets and goals will not suffice to meet the challenge. We need goals that will generate realistic "bottom line" productivity improvement:

2.5% (or better) by 1982

3.0% (or better) by 1985

4.0% by 1990

. . . and then at least compound the GNP net effective growth by 4.0% annually.

Most groups understand readily that the destruction of productive facilities in Japan and Germany during World War II, and to a lesser extent in France, gave them the opportunity to rebuild using the latest innovative technologies, equipment, facilities, and productive processes. That this happened largely with the help of U.S. resources and capital should not be challenged as improper or wrong. It was the humane and economic policy to follow. That other countries started new, while our productive assets remained to be amortized gradually meant that there was no corresponding influx of new technologies and productive processes into the U.S. industrial system except based on normal obsolescence, deterioration, or substitution of product. Availability of capital was a vital factor during the post war period and unfortunately, our tax policies did little to encourage its formation. Our competitive nations rebuilt physical plants and facilities, making use of the latest product technology and manufacturing processes. We now feel severely the imbalance of the above as evidenced by the productivity trend relationship of the U.S., and its economic competitors racing toward the all-too-near 1990 "breakeven" point.

Equally germane to the problem, but less subtle and therefore less recognized, is the fact that in Japan and Germany, particularly in World War II, the institutional structure of industry and government in place around the productive facilities, were largely destroyed or rendered impotent along with the facilities. This meant that both physical plant and institutional structures could be rebuilt compatible with the setting of national goals. Contrastingly, in the U.S., both productive, governmental, and other institutional structures remained largely unaltered except for growth. They kept pace with or exceeded the productive growth but, like the mastodon, they became huge, cumbersome, and today, not only largely ineffective, but actually counterproductive as a guiding force.

Our competitor's system permitted the almost instantaneous marshaling of government, financial, industrial, academic resources to the attainment of consensus national and international goals. They chose, in Japan (ie., through MITI largely), goals of enhanced industrial productivity, and a foremost international trade and economic position among nations, and mobilized resources toward their attainment.

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Current Environment

The U.S. plant and institutional structure produced industrial products for itself and the world on a "catch up" basis. There was little competitive pressure to emulate the Japanese or Germans in their strategic plans. While their institutions concentrated on national goals, ours decentralized and became divisive to the point of reaching an adversarial climate among government, industry, and academia, rendering it almost impossible to set consensus goals and develop strategic plans.

In this environment in the United States:

1) The productivity rate is declining rapidly.

2) Capital formation and investment in productive facilities is declining because financial resources are being removed from the control of the private industrial sector. (Corporate taxes have increased from 38% to 48% from 1966-1976.)

3) Average return on investment has decreased from 10% (1965) to 4% (1977). At a 4% rate of return on productive investment, there are many better places for resources with less risk of capital loss.

4) The rate of technology transfer from generic technology to useful products is declining rapidly.

5) The rate of generation of new, useful technology and innovation is decreasing rapidly.

6) Education of people resources in new technology usage and product application lags badly.

7) New goals of environment, energy, and safety have constricted individual initiative and preempted the use of resources from industrial product wealth generation. They have created a regulative climate that severely restricts entrepeneurial initiative based on good sound scientific and engineering research and development.

It is true that during the period since World War II, we have generated jobs for a phenomenal number of people entering the labor market, and held our unemployment rate low. But this has been based on our absolute productivity lead that supported the primary industrial and secondary service market. By 1990, unless we act, this slim advantage will have disappeared. Other industries and employment opportunities will have joined steel, autos, shipping, textiles, photographic equipment, consumer electronics (radios, televisions, etc.), in their abdication to other countries. We will be further pressed by the rapidly increasing resources, education, and initiative of the LDC's (Less Developed Countries), as head-to-head competitors for world position.

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Correction Policies

It is the purpose of this document to recommend constructive steps to be taken to alleviate and terminate the decline of U.S. productivity. We should, from a planning sense:

1) Accept the fact that we have a serious productivity problem impacting our economic existence, and that no single group caused it. To some degree, we all contributed either by action or inaction, however sincere our motivations.

2) Set goals to:

   a) Reverse our productivity rate decline trend by a practical attainable point in time.

   b) Stabilize our world economic position with constructive international policies.

   c) Enhance the utilization of our physical and human resources.

3) Establish strong and aggressive policy initiatives to accomplish our national productivity goals.

4) Mold and change as necessary our institutional structures (government particularly) to carry out our productivity policy initiatives.

We should implement our goals and policy initiatives by:

1) Creation in-so-far as possible, of a U.S. entity similar to that of the Japanese Ministry of International Trade and Industry and other nations which would be dedicated to the attainment of our consensus productivity goals.

2) Reconstitute and reorder our government institutional structure to complement the productivity entity. (i.e. follow-through and strengthen the Department of Commerce reorganization to better attain commercial and technology goals.)

3) Identify productivity targets of opportunity and guide human, physical, and financial resources toward their attainment.

Overall policy and goals should:

1) Channel funds to the private productive sector.

2) Encourage private over government solutions.

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As this is written, there are many groups within government and outside that recognize the imperative need for action to permit the results of more efficient uses of capital, labor, materials, and processes, to fall through to the "bottom line" of productivity increases and contribute to regaining both national and international economic and technological leadership. They need only to be coalesced to each make a major contribution to the process.

Many of these groups and institutions have unique indepth knowledge of the problems of incentive taxation, capitol formation and effective use, antitrust blockages, education, motivation, and lastly, but probably the most important, the encouragement of research and development, and its effective timely transfer to innovative products and processes. Requirements of our massive environmental and energy programs will largely control the products needed from our industrial productive areas. But to meet these, as they become known, the scientific, engineering, and technical communities need to marshal their great "know how" into the processes needed to produce them quickly, efficiently, and world competitively.

The Society of Manufacturing Engineers, and others in the technical community, believe our highest priority for the short range is to encourage the transition of already known scientific data into needed physical products by improved processes using technologies such as the computer and our advanced manufacturing capabilities. To do this, it suggests analogously a mechanism similar to (but not to be completely copied) that used to promote the growth of our agricultural system. We suggest steps to immediately encourage the cooperation of U.S. industry, government, academia and the technical and professional community to attack the common problem with their great resources, whose combined impact is much greater than the impact of each of its individual parts. (See Attachment I -- "The National Role and Importance of Manufacturing Engineering and Advanced Manufacturing Technology" -- Society of Manufacturing Engineers, May 8, 1978.)

More specifically, dealing with the institutional mechanisms to encourage development of technologies and their application, a second document "Cooperative Technology -- An Action Alternative for Productivity Advancement" -- Society of Manufacturing Engineers, April 30, 1979, addresses and suggests the catalytic role (but not necessarily the governing role), that government can play in this vital area. (See Attachment II.)

The luxury of partisan and group politics leading to adversarial and litigative "due Process" attempts to solutionize our problems, and has proceeded to the point of counterproductivity and now adds momentum to the decline of our productivity. It, therefore, must draw back to reasonable thrusts to guarantee adequate, but not overpowering, debate to ensure consensus leading to the institution of national policies and programs to:

1) Promote effective research and development on an expanded scale, with particular emphasis on manufacturing processes.

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2) Promote quick and effective transfer of leading edge technologies into new product and manufacturing process by:

a) Depreciation schedules that are more compatible with the real world of obsolescence.

b) Changes in the patent law to permit individual innovative entrepreneurs to retain adequate proceeds from their inventive efforts.

c) Encourage, by tax law changes, the formation of small enterprises based on new research and technology (fall off in rate of formation of small firms since tax law changes in 1969 is almost total.)

d) Encourage meaningful interface mechanisms to permit timely in-flow of new foreign technologies to the U.S.

e) Accelerate the development of government policies, legislation, and regulation designed to encourage more effective use of our human resources, through training, education, and recognition of support need for new and evolving skills and technical careers.

f) Streamline the myriad components of the Government, Executive Branch, Congress, technical and scientific committees, etc., to work more efficiently to identify goals and promote policies leading to the rapid solution of our productivity problem.

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ATTACHMENT I

THE NATIONAL ROLE AND IMPORTANCE OF MANUFACTURING ENGINEERING AND ADVANCED MANUFACTURING TECHNOLOGY

Position Paper by:
Society of Manufacturing Engineers'
Government Relations Committee

Approved by the SME Board of Directors
May 8, 1973

SOCIETY OF MANUFACTURING ENGINEERS

Exhibit A

The National Role and Importance of Manufacturing Engineering and Advanced Manufacturing Technology

The Society of Manufacturing Engineers recommends a national commitment to the improvement of productivity through advanced manufacturing technology. The urgency of this recommendation cannot be overstated. Nor can the consequences of our failure to act be ignored without endangering the national economy and the ultimate welfare of the nation. Suggestions as to an appropriate course of action are contained in this paper and in the attached enclosure.

The Analogy of Agriculture. Since its founding more than 200 years ago, the United States has evolved from an agrarian into an urban culture. In 1776, more than 90 percent of the population was involved in agriculture. Today less than 5 percent of the population is associated with agriculture. Despite this decline in numbers, Americans today have a higher per-capita consumption of food than at any time in the nation's history. Further, the variety of foods has increased, and the levels of food stocks exported have risen exponentially. Despite our greater consumption of food and our increasing exports, the abundance is such that the modern farmer must be subsidized as a way of curtailing the amount of land farmed and the size of the crops obtained.

The resounding success of American agriculture begs a question: Can this success be duplicated in industry? The answer, we believe, is yes. This answer derives from an examination of the history of agriculture, a few highlights of which can be briefly summarized as follows:

In 1862 the federal government established the Department of Agriculture. By the Merrill Act--enacted that same year--the federal government established the land-grant college system. This system has, for more than a century, trained countless numbers of young men and women in advanced agriculture technology.

The land-grant colleges also have large experimental stations which conduct important research in agricultural methods and processes. Importantly, the colleges also train government personnel in the latest findings. The government personnel then update the farmers through personal contact and published reports.

Thus the federal government has established a highly effective system through which it continually searches out higher-productivity agricultural methodologies which are then relayed to the actual practitioners in the field. It is a system that has increased the productivity of American agriculture to a point where it is the envy--and the wonder--of the rest of the world.

Application to Industry. The American industrial system, although still the most powerful in the world, is beset with problems which could in the end prove fatal. It is the contention of the Society of Manufacturing Engineers that this malaise can be corrected through the development and utilization of a system similar to the agricultural system previously described. Accordingly, the Society recommends the following:

1. That the existing federal programs for the development of manufacturing technology be supported and strengthened.

2. That the Department of Commerce be restructured to support and encourage the development of Advanced Manufacturing Technology programs for the improvement of industrial productivity.* This effort should include (a) an examination of the possibility of assisting in the establishment of manufacturing engineering curricula in colleges and high schools, and (b) the funding of research in advanced manufacturing technology and (c) assisting in the transfer of such technology to industry.

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*Enclosure 1 to this paper is a discussion of industrial productivity today.

The National Role and Importance of Manufacturing Engineering and Advanced Manufacturing Technology

The economic health and well-being of an industrial nation goes hand-in-hand with the health and well-being of its manufacturing industries. This is so for two excellent reasons, the first of which is that manufacturing accounts for approximately one-third of the gross national product (GNP) of such nations.

Secondly, manufacturing is the principal wealth-producing activity of modern industrialized nations. Services account for approximately one-half of the gross national product of most industriallized nations, but services are not wealth-producing activities. They depend for their support on the wealth-producers, i.e., the extractive (agriculture and mining) industries, the construction industry, and the manufacturing industry. It can be shown without difficulty that manufacturing accounts for approximately two-thirds of the wealth produced in modern industrial nations.

A Statistical Breakdown. In the case of the United States, the latest available statistics--those for 1974--show that manufacturing accounts for approximately 23 percent of the GNP. The extractive and construction industries account for about 11 percent and services for the remaining 66 percent. From this it follows that manufacturing accounts for about 68 percent of the direct wealth-producing activity of modern America.

Advanced Capabilities--Greater Requirements. The health of a nation's manufacturing industry is measured by its ability to survive and to compete with other nations in the marketplace--its own and the world's. The primary determinant of its health is the quality and sophistication of its manufacturing technology. In amplifying upon this statement, two factors are of paramount importance:

- The Computer. Originally designed for computational and clerical purposes, the digital computer has moved into a position of dominance in modern manufacturing. It is the sine qua non of all manufacturing systems in which automation, control, and optimization of hardware and software are considerations. It can be said that the sophistication of a manufacturing system is directly proportional to its effectiveness in utilizing computer technology.

- Economic and Social Pressures. Powerful economic and social pressures have come to bear on manufacturing in the past decade. For the most part, these pressures are associated with productivity and the growing reluctance of people to work in the manufacturing industry.

Productivity. The decline in manufacturing productivity is a world-wide phenomenon. To assess its impact on the American economy and the economy of the free world in general, the Society of Manufacturing Engineers has studied the productivity and costs statistics for ten Western nations: Belgium, Canada, France, West Germany, Italy, the Netherlands, Sweden, Switzerland, the United Kingdom and the United States. Also studied were the same figures for Japan. These figures are both enlightening and shocking. For example:

1965 to 1970. During this period, manufacturing productivity, as measured in output per man-hour, increased at an average annual rate of 6 percent. But manufacturing labor costs, as measured in compensation per man-hour, increased at an average annual rate of 9 percent.

This is an unhealth situation because a negative differential between productivity and labor costs unleashes powerful inf ationary forces. But let us now look at the subsequent five years:

1970 to 1975. Manufacturing productivity rose at an average annual rate of only 4.5 percent. Manufacturing costs rose at an annual average rate of nearly 21 percent.

And thus we come to the roots of the inflation that has plagued the Western Bloc nations and Japan for the past fifteen years. But before prescribing a cure, let us examine the statistics for the United States alone:

1965 to 1970. Manufacturing productivity increased at an annual rate of 2.1 percent. Manufacturing labor costs increased at an average annual rate of 6.0 percent.

1970 to 1975. Manufacturing productivity increased at an average rate of 2.0 percent. Manufacturing labor costs increased at an average annual rate of 9.5 percent.

The implications of these figures lead to a single conclusion: That manufacturing costs must be reduced through the increased application of advanced manufacturing technology.

A Proven Concept. The development and application of advanced manufacturing technology has demonstrated its capability to reverse this otherwise disastrous national and international trend. In the field of metalworking manufacturing, prototype computer controlled manufacturing systems are operating on a semi-experimental basis in Japan, West Germany, and the United States. These systems have demonstrated an ability to increase the productivity of batch type parts-making by several hundred percent. Similarly, they have demonstrated their ability to reduce labor costs in such operations by 80 percent and more.

Social Pressures. In most industrialized nations, the percentage of the workforce that is willing to work in manufacturing jobs is constantly shrinking. In the United States the trend has been clearly downward since the end of the Second World War. Professor Daniel Bell of Harvard, who has been studying this trend, cites some interesting and informative statistics on this subject in his book The Coming of the Post Industrial Society.

In the period 1968-1980 Prof. Bell sees the total available workforce in the United States expanding by some 23 percent. The service-producing activities are expected to increase by approximately 31 percent. But the goods-producing activities (the manufacturing industry) will increase by only 9 percent.

Looking backward to the beginning of the trend, in 1947, 30 percent of the workforce in the United States was employed in manufacturing. By 1968 the percentage figure had dropped to 24.9. The Bureau of Labor predicts a dropoff of 22.4 percent by 1980. And Prof. Bell predicts that it will be down to 10 percent by the year 2000.

But it is imperative that the manufacturing industry continue to grow throughout this period, since it is the principal wealth-producing activity of the country. And because the migratory drift of workers away from manufacturing and into the services sector is apparently irreversible, new manufacturing methodologies must be employed. These methodologies will provide an even greater flow of manufactured goods; they will sustain this flow with far fewer people. They will involve computerized systems that are almost completely automated.

The Digital Computer. It is said that the introduction of the digital computer heralded the advent of a new revolution in manufacturing. It is more likely that the entry of the computer to manufacturing marks the beginning of the ultimate and final phase of the Industrial Revolution. These points of view represent philosophical differences that will be resolved by scholars as yet unborn. For our purposes it suffices that the digital computer provides the wherewithal to solve the principal problems outlined in this paper: declining productivity and the growing distaste of people for work in manufacturing systems.

To measure the impact of the computer on manufacturing, and to develop statistically valid data concerning its future impact, the Society of Manufacturing Engineers, in cooperation with The University of Michigan and the National Machine Tool Builders Association, has undertaken a number of Delphi* studies. The first study, published in May, 1977, included the following points in its forecast:

1. By about 1982, approximately 10 percent of the total machine tool production will be used in integrated, computer-controlled manufacturing systems. These systems will be equipped with automated parts handling equipment for workpiece movement through the system. Like the machine tools, the material handling equipment will be under the control of a central computer.

2. By about 1985, computer software systems for the automation and optimization of all steps in manufacturing planning will be used by at least 25 percent of the manufacturing industry. These steps include the development of machining sequences, the selection of the necessary machine tools, clamping, the selection of operational sequences, tool selection, the selection of optimum cutting conditions, and the like.

3. By about 1987, approximately 38 percent of the total manufacturing systems will be equipped with diagnostic sensors and the associated software for detecting and correcting breakdowns in the system.

*Delphi forecasting is a statistically valid methodology for predicting future events on the basis of current trends. The methodology was developed by the Rand Corporation to answer certain questions related to the national security. Rand's development and subsequent use of Delphi forecasting provided satisfactory answers. Rand's naming of the process for the classical oracle of Delphi must be regarded as classical whimsy.

These points and numerous others made in the Delphi study underscore the fact that the computerization of industry will become an irreversible fact of life before the end of the century. Before this happens, however, certain changes in our approach to the related research and development are mandatory.

A Cooperative Endeavor. Many nations have recognized the two inevitable facts concerning computerized manufacturing. The first is that they must develop systems of the type discussed in this report if they are to survive as world powers. The second fact is that the development of such systems calls for cooperative effort on a national scale. A number of such efforts are now being implemented throughout the world. These efforts are all-inclusive in that they involve cooperative action by the manufacturing industry, universities, government, trade associations and technical societies related to, or affiliated with, the manufacturing industry.

The Japanese Effort. The example provided by Japan is worthy of study and possibly of emulation. Japan has made the development of computerized manufacturing a national program in which work is divided among the following:

1. Universities. Basic research in a multitude of small projects. Average funding: $30,000 each.

2. Government Laboratories. Applied research in a variety of medium sized projects. Average funding: $300,000 per project.

3. Industrial Companies. Development in a limited number of large projects jointly funded by government and industry. Average funding: $3 million.

The background study, planning and coordination of this work is accomplished through a number of committees. The structures of these committees include representatives from industry, the universities and government. The related organizational and administrative work is accomplished through appropriate trade associations and technical societies. Government and industry share in the necessary funding.

One especially noteworthy result of the Japanese approach is the recent planning of a national program called "Methodology for Unmanned Manufacturing." The purpose of this program is to develop and implement a number of computer-automated and optimized manufacturing plants. The first step in this program is to be the development of a small prototype, scheduled for operation by 1984. The Ministry of International Trade and Industry has contributed $50 million to the funding of this effort, thus giving a testimonial of sorts to the seriousness of the Japanese effort.

Other nations are developing cooperative programs similar to Japan's. The most significant to date are now aborning in West Germany, Norway, East Germany, Czechoslovakia and the Soviet Union.

The Abortive American Effort. Similar attempts to develop a cooperative approach to the automated factory have not fared so well in the United States. A small

amount of basic research was being funded by the National Science Foundation. But even this effort, which was small compared to that of our overseas competitors, suffered a serious setback with the dismemberment of the RANN Division of NSF. For it was RANN that provided the necessary support.

Two other items tend to support the contention that there is little or no interest on the part of the federal government in computer-aided and computer-optimized manufacturing. One is the budget cutback for the newly launched Air Force/DOD program on Integrated Computer Aided Manufacturing. Importantly, this cutback came in the program's first full year of operation.

The other item is the fact that the excellent report of the Comptroller General of the United States to the Congress has received virtually no response from that body. And yet the report entitled Manufacturing Technology--A Changing Challenge to Improved Productivity, defines the problem and its consequences in devastating detail.

The Needed American Effort. The wealth-producing function of manufacturing is fundamental to the economic well-being of America. It is an area of human endeavor in which we have been dominant for several generations and one in which our still formidable capabilities have given us a flow of material goods unprecedented in world history. It is an area in which we have functioned superlatively well without government support but with government intervention--much of it unnecessary.

But now the rules of the game are changing, largely because of the growing complexity of technology and the speed with which it is evolving. There was a day--not long ago--when each intelligently managed industry could easily assimilate change and make the necessary adaptations.

But the continuing and rapidly accelerating evolution of industry has now brought us to the gates of the automatic factory. To step inside calls for a greater effort than any one industry can make on its own. We can proceed no further without a cooperative effort in which industry, academia, the federal government and the technical societies join hands--as is now being done in Japan, Norway and West Germany.

The alternative? The rapid decay of American industry and the degeneration of America itself into a small and unimportant industrial backwater. It is an alternative that we need not--and cannot--contemplate.

Attachment II

COOPERATIVE TECHNOLOGY--AN ACTION ALTERNATIVE FOR PRODUCTIVITY ADVANCEMENT

Position Paper by:
The Society of Manufacturing Engineers

Approved by the SME Board of Directors
April 30, 1979

COOPERATIVE TECHNOLOGY—AN ACTION ALTERNATIVE FOR PRODUCTIVITY ADVANCEMENT

On May 8, 1978, the Board of Directors of the Society of Manufacturing Engineers (SME) issued a position paper entitled "The National Role and Importance of Manufacturing Engineering and Advanced Manufacturing Technology." This paper confirmed and reinforced the conclusions drawn in earlier studies conducted by the U.S. General Accounting Office. In so doing, it underscored the urgent need for a national commitment to productivity improvement through advanced manufacturing technology. The SME paper also recommended the strengthening of existing federal programs designed to alleviate the problem of declining productivity.

The position taken by SME in this paper was--and is--strongly supported by other technical societies and associations, and by acknowledged authorities on the productivity crisis. It is noteworthy that the SME paper was extensively quoted by the National Center for Productivity and Quality of Working Life in its final report, entitled "Productivity in the Changing World of the 1980's."

A strong--indeed, an undeniable--consensus has emerged. The consensus is that federal support, in one form or another, must be forthcoming if American scientific and technical superiority is to be restored. Further, this scientific and technical superiority is an imperative if the nation is to attain the ancillary benefits of economic growth, an improved competitive posture in the world marketplace, and the technological capabilities necessary to an impregnable national defense.

The consensus is manifest. A consensus as to how government can best be involved is far less explicit. There are two strongly supported alternatives worth noting, however. They are as follows:

- Direct Participation. Federal assistance in technological advance would be given through the funding of basic research through government procurement policies, through stimulation of innovative enterprises, and through assistance in technology transfer and manpower training for low-growth industries.

- Economic Policy. Federal assistance would be given through a national economic policy designed to amplify the incentives and funding for expanded research and development. Included in this policy would be inflation control, tax credits, reduced regulatory constraints, and modification of antitrust and patent policies.

It is the contention of SME that these interrelated problems in productivity and innovation--as well as many of the alternatives for corrective action--have been well identified by industry for nearly a decade. However, the more recent inquiries and investigations have served (1) to clarify the need to coordinate technological advance with national social and economic goals, (2) to identify the industry segments that are not competitive in world markets, and (3) to identify blockages requiring federal policy adjustments.

Additional byproducts of these investigative efforts by Congress, the Department of Commerce, the General Accounting Office, the National Center for Productivity, and the Office of Technology Assessment have been the generation of relevant statistical data, coordinating techniques, and the development of people-skills essential to a continuing federal involvement in this crucial issue.

The present need—and it is a need of utmost urgency—is to establish an organizational mechanism to implement and apply these findings to a positive program for corrective action.

In its 1978 productivity position paper, SME suggested a restructuring of the Department of Commerce. It further suggested that the restructured department could serve as a focal point for affirmative action in implementing the position paper's advanced manufacturing technology program recommendations.

The Society has been encouraged by the Secretary of Commerce's formation of an Industrial Innovation Coordinating Committee charged with responsibility for the development of specific federal policy recommendations. This initiative has also generated a proposal for a Cooperative Technology consortium in which private enterprise, government, and universities would focus on fundamental technologies which underlie a wide range of industrial needs.

The Cooperative Technology Program*, to be administered by the Assistant Secretary of Commerce for Science and Technology, is a positive and potentially meaningful concept aimed at the improvement of industrial productivity. As presently perceived, the Cooperative Technology concept will stimulate action with respect to industry-identified technical needs related to basic or applied research. This research would be in areas of major national interest which are not adequately addressed by the private sector because of industry fragmentation or a lack of market incentive.

Through the Cooperative Technology concept, the government would support, but not totally fund, technical needs which have been identified by industry. These needs would usually be met by applied research carried out at university centers. There are a number of reasons why SME feels that this program should be supported:

1. By requiring cooperation as the basis for continuation, it represents a step toward reducing the adversary relationship between government and industry.

2. The government role in the program is the appropriate one of facilitating private sector efforts. The government acts as a catalyst, but industry provides the financial support.

3. The program provides recognition that productivity improvement is an important national goal.

4. The program recognizes that technological innovation is important to the improvement of productivity.

5. The program will act to strengthen the relationship between industry and the university community.

The Society of Manufacturing Engineers has an established history of contributory involvement in productivity, technological innovation, technology transfer, and cooperative technology in the many fields of manufacturing.** On the basis of this experiance, the Society is highly supportive of both actions initiated by the Department of Commerce.

Accordingly, SME recommends the passage of satisfactory enabling legislation and encourages a strong national commitment to the new Cooperative Technology concept and organizational approach. SME feels that this form of Federal support of industrial technology advancement would reduce the adversial relationship that exists between government and industry, would provide a catalyst for action to improve productivity through technical innovation, and would strengthen the relationship between industry and the academic community.

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* Appendix A--"Cooperative Technology and the Society of Manufacturing Engineers" describes the Cooperative Technology Program as it relates to SME's sphere of interest and responsibility.

** Appendix B--"Productivity and the Society of Manufacturing Engineers" outlines SME's historical role and contributions to manufacturing productivity.

COOPERATIVE TECHNOLOGY—AN ACTION ALTERNATIVE FOR PRODUCTIVITY ADVANCEMENT

COOPERATIVE TECHNOLOGY AND THE SOCIETY OF MANUFACTURING ENGINEERS

The application of "cooperative technology activities" to assist or enhance specific industries or to generate new technology to meet specific national goals, does not represent a new Federal experience. It has been, and is being, effectively utilized in many programs within the Departments of Agriculture, Energy, Interior, Defense and Commerce, as well as other independent agencies.

The Manufacturing Technology Program within the Department of Defense is an example most familiar to SME. This program is specifically geared to insure economical and reliable production of defense materials through development of improved manufacturing processes, materials and equipment. SME's thrust is to broadly interpret and apply any major advances in manufacturing technology to the benefit of the private sector.

The National Science Foundation, through which much of the basic research expenditures of the government are channeled, is investing an increasing share of its resources in experimental programs for the application of fundamental science to industry problem-solving through cooperative technology mechanisms.

These programs have not been visibly oriented toward the productivity issue, however. Nor has the traditional governmental approach of investing in basic research, with the expectation that market forces alone will insure productive application, proven sufficient.

In its major role as a medium for technology transfer, the Society finds the greater need to be a new force to more rapidly accelerate the rate of implementation of existing technology in critical areas of the manufacturing sector.

A determination to effectively fill this critical void is clearly evidenced in planning efforts recently initiated by the Office of Science and Technology of the U.S. Department of Commerce. This is reflected in the stated objective of their Cooperative Technology Program:

> ". . . to spur production and accumulation of scientific and technical knowledge essential for industrial investment in the commercial development of critical technologies."

The mechanism for accomplishing this objective is fully compatible with the SME's 1978 position paper on productivity. The Cooperative Technology Program would:

- Increase the laverage of industrial funds by pooling resources to find solutions to common problems.
- Increase R & D funds to the critical level required for broad applicability to industry.
- Increase the capability of universities and technical institutes to support the effective utilization of technology in industry.

The planned mode of operation through Cooperative Technology Centers—industry-controlled but jointly-funded by industry and government—should insure work programs responsive to timely and real commercial needs. Properly executed, this program also has potential for a corrective contribution to an ailing national research and development environment.

Administration of the program, through an expanded function of the National Bureau of Standards, will provide a starting credibility, a multidisciplinary perspective, and a focal point for integration with other related government programs.

The Department of Commerce has already initiated case studies in several technologies being considered for Cooperative Technology Programs. These preliminary studies are being carried out to test industry response, identify current needs and to make cost benefit determinations. These include, among others: (1) welding; (2) industrial coatings; (3) computer aided design; (4) powder metallurgy; (5) semiconductor fabrication; (6) flexible manufacturing; (7) corrosion protection; (8) radiation processing; and (9) composites. All of these are considered to be of significant interest to SME or SME-affiliated societies.

CONCLUSIONS

The Cooperative Technology Program currently under development by the Department of Commerce is perceived as a viable action response to the expressed needs for Federal assistance in the innovation process. Successful implementation, with a stable long-term commitment to the plan concepts, should provide a significant new resource to combat the declining trend of national productivity. The proposed Cooperative Technology Program is fully compatible with, and should reinforce, the current programs and longer-range interests and strategies of the Society of Manufacturing Engineers.

This position recommendation carries with it an implied commitment for continuing application of the Society's resources to this common national purpose, in cooperation with this new medium of implementation. Support by SME is based on the conviction of urgency and need for constructive, as opposed to further investigative, action. The many impediments which must be minimized or eliminated to make this program truly effective, are fully recognized.

In the formative stages of the proposed Cooperative Technology Program, the Society will establish and maintain a close line of communication with the Office of Science and Technology. A diligent effort will be made to assist in their organizing efforts by offering technical expertise and the experience of our organization and membership in project planning and administration.

The short-term goal of this preliminary activity, to be controlled by the SME Technical Council, will be the selection of project alternatives related to the advanced manufacturing engineering needs which most satisfactorily meet federal, industry, and Society criteria.

COOPERATIVE TECHNOLOGY—AN ACTION ALTERNATIVE FOR PRODUCTIVITY ADVANCEMENT

PRODUCTIVITY AND THE SOCIETY OF MANUFACTURING ENGINEERS

THE SOCIETY PROFILE

The Society of Manufacturing Engineers is a professional technical society dedicated to advancing manufacturing technology through the continuing education of manufacturing engineers and managers. The specific goal of the Society is "to advance scientific knowledge in the field of manufacturing engineering and to apply its resources to research, writing, publishing, and disseminating information."

The Society was founded in 1932 as the American Society of Tool Engineers. From 1960 to 1969, it was known as the American Society of Tool and Manufacturing Engineers; in January 1970 it became the Society of Manufacturing Engineers.

The changes in name reflect the evolution of the manufacturing engineering profession, and the growth and increasing sophistication of a technical society that has gained an international reputation for being the most knowledgeable and progressive voice in the field.

The principal on-going activities of the Society include:

- Conferences and Expositions. Engineering conferences and expositions represent the most effective mediums for technology transfer. During 1978, 16 expositions and 32 conferences were held with total attendance exceeding 128,000.

- Educational Programs. 1978 educational activities included 65 three-day programs (clinics, seminars, workshops) devoted to a single subject, with technical paper presentations, problem-solving sessions and plant tours.

  The Society also offers academic course materials on all aspects of manufacturing for individual study or group instruction. These include programmed learning courses, home study courses, correspondence courses, and video-tape training programs.

- Publications. The principal periodical of the Society is MANUFACTURING ENGINEERING, published monthly and directed to the entire manufacturing community. A wide range of other publications deals more specifically with specialties within the broad spectrum of manufacturing engineering. These include the Tool and Manufacturing Engineers Handbook, Robotics Today, and the Manufacturing Data Series, consisting of 24 reference books on specific subjects within manufacturing engineering.

- Technical Divisions. SME's function is to follow and assess the trends and developments in manufacturing; then to interpret, publish and distribute the information. To tap the technical talents of its 50,000 members, SME sponsors 13 Technical Divisions. These are subdivided into 70 technical areas and encompass all of the disciplines of engineering and management in manufacturing. More than 1,000 volunteers contribute their time and talent to provide the technical input for SME's educational programs.

- Associations of SME. To serve the widening technical interests of manufacturing engineers, SME also has created, and serves as headquarters for, several other associations or technical societies. These include the Robot Institute of America (RIA), the Association for Finishing Processes (AFP/SME), the Association of American CIRP Industrial Sponsors (AACIS), and the Computer and Automated Systems Association (CASA/SME).

- Research and Educational Grants. In addition to sponsoring more than 30 student chapters, covering more than 4,000 students at universities and colleges throughout the United States, the Society supports a program of research and educational grants. Its purpose is to promote the development of manufacturing engineering curricula in colleges and universities, to help upgrade the level of instruction where such programs already exist, and to attract an even higher caliber of students to the profession.

  Since 1954, the Society has spent more than a half million dollars to sponsor research and provide capital equipment to educational institutions and to assist in the development of educational curricula.

- Standards. The Society works closely and continuously with the American National Standards Institute, the International Standards Organization, the American National Metric Council, and other national and international organizations. Its purpose is to help establish and maintain the highest possible standards in the field of manufacturing engineering for the benefit of industry and the profession.

  Among the many other organizations with which SME is affiliated are the Association for Cooperation in Engineering, the Engineers Joint Council, the National Council of Engineering Examiners, the American Automatic Controls Council, and the Federation of Materials Societies.

- Certification. Through its Manufacturing Engineering Certification Institute, the Society also certifies Manufacturing Engineers and Technologists for their technical expertise and knowledge acquired through on-the-job experience and informal education. Degreed personnel and registered professional engineers also may become Certified under this program, which was developed with the guidance and endorsement of industry.

THE SOCIETY AND PRODUCTIVITY

The constituency of the Society is primarily engineering professionals and technologists engaged in the manufacture of primary metal products, machinery, electric and electronic equipment, and miscellaneous manufactured products.

Historically, the Society has provided a forum for the expression of concern on various aspects of its members' job environments. Of special importance are the factors that limit growth and the achievement of personal goals. In the late 1960's, an awareness of a diminishing impact of their efforts and dedication to productivity improvement emerged from this forum. The causes, not then fully identified, were believed to be related to factors beyond either individual or management control.

The first responsive action to these concerns led to SME co-sponsorship with the National Science Foundation and the National Bureau of Standards of a "Manufacturing Productivity Conference" in October, 1972. A primary result of this conference was the aggressive application of Society resources to the clarification of problems and the assessment of alternatives for constructive action. Some of the more significant events and actions which occurred as a result of this thrust are as follows:

- Cooperation with the U.S. General Accounting Office in the development of information for their study on "Manufacturing Technology— A Changing Challenge to Improved Productivity." This was further extended to interpretation and dissemination of the study results and conclusions most relevant to the interests of the SME constituency.

- Cooperation with the National Center for Productivity and Quality of Working Life in their continuing efforts to focus public awareness on productivity problems and the influence of federal policies on productivity.

- Active participation in the Department of Defense sponsored Manufacturing Technology Advisory Group Conferences, recognizing that the prime determinant of the strength of our tri-services defense capabilities is highly dependent on the degree of advancement of manufacturing technology.

- Active participation in the Air Force Integrated Computer-Aided Manufacturing Program aimed at the technology required to reduce the metalworking manufacturing process to total automation from initial design to finished product.

- Active support of the robot industry and university institutes in pioneering efforts in promotion of advanced robotic technology. Since 1974, SME has co-sponsored an International Symposium on Industrial Robots on an annual basis.

These participating activities reflect a continuing SME effort to integrate and coordinate government, university, and private industry resources in the development and application of advanced manufacturing systems. They continue to

demonstrate the fact that the basic technology, spawned in the massive atomic energy, space, and communication systems investments, are not approaching their potential for optimization and versatile automation of our factories.

A further consequence of this realization has been the internal restructuring of the Society's organization and programming emphasis. These changes have included the following:

- The annual organization and implementation of a comprehensive conference and exposition on Computer Aided Design and Manufacturing (CAD/CAM) since 1972.

- North American Industrial Robot Conference during the years when international conferences are held abroad.

- The formation and incorporation of the Robot Institute of America to strengthen and support robot technology and its application in industry.

- The organization of a new affiliated Computer and Automated Systems Association (CASA/SME) in 1976 to provide a forum for technical dialogue between a variety of engineering disciplines and to serve as an educational vehicle for its membership.

- The formation and incorporation of an Association of American CIRP Industrial Sponsors to provide an independent medium for interchange of research needs and ideas, international technology transfer, and sponsorship of joint research on broad aspects of production engineering.

- The organization and implementation of annual AUTOFACT Conferences and Expositions. These events recognize the ultimate need for integration of the many engineering technologies in robotics, computer applications, numerical control, and automation essential to attainment of the highest productivity goals. It addresses the future needs of an all-encompassing advanced manufacturing technology.

- The formation of an affiliated Association for Finishing Processes (AFP/SME). This new organization was organized specifically to address emerging problems in development or adaptation of finishing systems to comply with volatile emission control, energy conservation, and toxic material handling regulations. It has provided the principal forum for technical information exchange since 1972 with major conferences and seminars on powder coating, radiation curing, water-borne and high solids coatings, and pretreatment technologies.

Stimulation, reinforcement and amplification of these accelerated efforts has been obtained by contracting for independent studies and surveys by established agencies. The first of these, entitled The Manufacturing Engineer—Today and Tomorrow, was conducted by A. D. Little in July, 1968. The principal motivation was the need for forecasting future educational needs, although its strongly signaled the technological changes we are now addressing.

A recent update entitled The Manufacturing Engineer--Past, Present and Future, conducted by Battelle Laboratories in May, 1979, reaffirms and more clearly defines the technological changes occurring in manufacturing while emphasizing the need for educational adaptation.

The Delphi techniques for technological forecasting were applied by the University of Michigan in major studies of the direction of technological change in four areas of specific interest to the Society constituency. These include:

Manufacturing Systems and Material Removal	May 1977
Manufacturing Management and Assembly	May, 1978
Quality Assurance	In process
Computer Aided Manufacturing	In process

CONCLUSIONS

This itemization of SME's expanding involvement in the promotion and application of advanced manufacturing technology reflects the body of thought now emerging as a national awareness. This decade of Society experience represents countless hours of valuable voluntary effort and contributions by engineers and technologists with personal dedication to professional and technological advancement.

It is significant that their independent rationalizations, as reflected in these activities, now converge with the observations and conclusions of industrial leaders, economists, and political planners.

Society efforts to stimulate innovation, to promote the application of advanced technology, and to break down communications barriers among engineers, industry, government, and educational institutions have made modest progress with limited financial resources. Even more significantly, the process has generated broad lines of communication, a credibility and competence base, and an understanding of the implementation problems to effectively contribute to an accelerated national productivity improvement program.

Enclosure D

MM78 - 968

TECHNICAL PAPER

INDEX TERMS

Manufacturing
Education

SUMMARY EVALUATION OF ECPD ACCREDITED BACCALAUREATE MANUFACTURING (ENGINEERING) TECHNOLOGY PROGRAMS

By

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ABSTRACT

This paper summarizes the curricula of the six Manufacturing (Engineering) Technology Programs presently accredited by ECPD. The summary sheet included identifies the various areas of course work included in each of the Programs. From the summary, a list of the most commonly used courses or course areas has been prepared. This listing has been further developed to describe a typical Manufacturing (Engineering) Technology Baccalaureate Program.

1978
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Creative Manufacturing Engineering Programs

INTRODUCTION

This paper summarizes the curricula of the six Manufacturing (Engineering) Technology Programs presently accredited by ECPD. The summary sheet included identifies the various areas of course work included in each of the Programs. From the summary, a list of the most commonly used courses or course areas has been prepared. This listing has been further developed to describe a typical Manufacturing (Engineering) Technology Baccalaureate Program.

METHODOLOGY

Current catalogs were collected for each of the six institutions as well as sheets 19 and 20 of the ECPD questionnaire (E. Graduation Requirements in Each Program.) This data, with some minor revisions, was transferred to the summary sheet to identify and categorize the course work taken in each of the respective areas as described by ECPD. Obviously, it was necessary to subjectively group each of the individual courses into commonly used groupings, particularly in the technical course work area. This reduced the number of different technical courses to a manageable list of 22. For those course areas having significant data, minimums, maximums and average values were calculated and ranking of frequency of inclusion were made. These rankings and frequencies were the basis for the development of a typical Manufacturing (Engineering) Technology Baccalaureate Program.

RESULTS

1. Table I shows the Data Summary of ECPD Accredited Baccalaureate Manufacturing (Engineering) Technology Programs.
2. Table II shows a breakdown of Manufacturing (Production) Process courses found in Table I, Technical Courses, C.
3. Table III shows Frequency Ranking of Courses.
4. Table IV shows a typical baccalaureate Manufacturing (Engineering) Technology Program.

CONCLUSIONS

1. Mathematics - all programs include college algebra and trigonometry, calculus (four of which included analytical geometry) and computers.
2. Basic sciences - most programs include both physics and chemistry. However, there appears to be a preference of physics over chemistry in both frequency and course hours.
3. Written and oral communication - it is presumed that composition is included in all programs although neither the ECPD data nor the bulletins indicated that it is required in all cases. Technical and/or business writing is included in five of the six programs.

CONCLUSIONS - Continued

It is noted that speech is required in only one program.

4. Humanities and social sciences - four of the six programs require a course in economics.
5. Technical courses - a Manufacturing (Engineering) Technology Program includes the following:

   a. drafting (graphics, descriptive geometry, etc.), manufacturing (production) processes, statics (mechanics), and electrical (electronics, instrumentation) courses are included in all programs,
   b. materials (metallurgy), design (tool, machine, jig and fixture, etc.), and quality control (NDT) courses are included in five of the six programs,
   c. hydraulics (fluid power, fluid mechanics, pneumatics, etc.), and numerical control courses are included in four of the six programs,
   d. strength of materials, dynamics, methods (motion and time study), production planning and control, controls, plant lay-out, and seminar (projects) courses are included in three of the six programs,
   e. manufacturing management and thermodynamics courses are listed in two of the six programs,
   f. general (introduction), mechanisms, and safety courses are listed in only one of the six programs.

6. Physical education and ROTC - four of the six programs include physical education as a requirement.
7. Other non-technical courses - there appears to be no solid pattern in the non-technical area. It is noted that supervision, business and management courses did not show a more solid requirement in the programs.
8. All programs satisfied the ECPD minimum requirements with the total number of hours ranging from 122 to 134.7 with an average of 130.6.
9. This summary provides significant and sufficient data to be used in the development of the typical baccalaureate Manufacturing (Engineering) Technology program.

DISCUSSION

This paper was undertaken to assist emerging Manufacturing (Engineering) Technology programs in their development and quest for recognition. It gives a fairly comprehensive overview of the type of programs presently ECPD accredited as to the balance of course work being utilized. The material in this paper, in conjunction with bulletins of other manufacturing technology programs, and with industrial advisory groups should provide sufficient input material for the initiation and/or development of Manufacturing (Engineering) Technology baccalaureate degree programs.

TABLE 1

DATA SUMMARY OF ECPD ACCREDITED MANUFACTURING (ENGINEERING) TECHNOLOGY BACCALAUREATE PROGRAMS

		A	B (Quarter Hours)	C (Quarter Hours)	D	E	F
MATHEMATICS		18	(23) 16 2/3	(28) 18 2/3	12	12	16
A. Pre-Algebra & Trigonometry	A.		A.	A. (5)	A.	A.	
B. Algebra and Trigonometry	B.	4	B. (5)	B. (10)	B. 6	B. 3	B. 6
C. Analytical Geometry	C.	Inc. in Calc.	C.	C.	C. Inc. in Calc.	C. Inc. in Calc.	C. Inc. in Calc.
D. Calculus	D.	9	D. (12)	D. (5)	D. 3	D. 4	D. 6
E. Computer	E.	1	E. (5)	E. (9)	E. 3	E. 2	E. 4
F. Statistics	F.		F.	F. (4)	F.	F. 3	F.
G. Engineering Analysis and Program Solving (Computations)	G.	3	G. (3)	G.	G.	G.	G.
BASIC SCIENCES		10	(19) 12 2/3	(17) 11 1/3	12	12	8
A. Physics	A.	6	A. (12)	A. (12)	A. 6	A. 8	A. 8 or
B. Chemistry	B.	4	B. (4)	B. (5)	B.	B. 4	B. 8
C. Life Sciences	C.		C. (3)	C.	C. 6	C.	C.
WRITTEN AND ORAL COMMUNICATIONS		3*	(8) 5 1/3	*	6	18	6
A. Composition	A.		A. (3)	A.	A. 3	A. 6	A. 3
B. Technical (Business) Writing	B.	3	B. (3)	B.	B. 3	B. 3	B. 3
C. Speech	C.		C.	C.	C.	C. 3	C.
D. Literature	D.		D.	D.	D.	D. 6	D.
E. Seminar	E.		E. (2)	E.	E.	E.	E.
HUMANITIES AND SOCIAL SCIENCES		3*	(27) 18	(5) 3 1/3	11	9	27
A. Economics	A.	3	A. (6)	A. (5)	A. 3	A.	A.
B. Humanities Electives	B.		B. (3)	B.	B. 6	B.	B. 8
C. Social Science Electives	C.		C.	C.	C. 2	C.	C.
D. Literature	D.		D. (3)	D.	D.	D.	D. 3
E. History	E.		E. (3)	E.	E.	E. 6	E. 6
F. Government	F.		F. (3)	F.	F.	F.	F. 6
G. Psychology	G.		G. (3)	G.	G.	G. 3	G.
H. Philosophy	H.		H. (6)	H.	H.	H.	H.
TECHNICAL COURSES		64	(94) 62 2/3	(107) 71 1/3	69*	70	57
A. General (Introduction)	A.		A.	A.	A. 1	A. 3	A.
B. Drafting, Graphics, Descriptive Geometry	B.	2	B. (4)	B. (13)	B. 3	B. 3	B. 3
C. Mfg. (Production) Processes	C.	28	C. (23)	C. (30)	C. 22	C. 13	C. 3
D. Mfg. Management	D.	3	D.	D.	D. 3	D.	D.
E. Materials - Metallurgy	E.	3	E. (9)	E.	E. 6	E. 3	E. 8
F. Statics-Mechanics	F.	3	F. (3)	F. (4)	F. 3	F. 3	F. 3
G. Strength of Materials	G.	3	G.	G. (4)	G.	G.	G. 4
H. Dynamics	H.		H. 4	H.	H.	H. 3	H. 3
I. Design (Tool, Machine, Jig and Fixture)	I.		I. (18)	I. (12)	I. 3	I. 3	I. 4*
J. Hydraulics (Fluid Power, Fluid Mechanics, Pneumatics)	J.		J. (3)	J. (3)	J. 3	J.	J. 3, (1**)
K. Electrical (Electronics, Instrumentation	K.	4	K. (14)	K. (14)	K. 3	K. 8	K. 3
L. Numerical Control	L.	9	L. (3)	L. (6)	L. 3	L.	L.
M. Methods, Motion & Time Study	M.		M.	M. (3)	M.	M. 3	M. 3*
N. Quality Control and MPT	N.	6	N.	N. (3)	N. 3	N. 3	N. 3*
O. Production Planning (Control)	O.		O.	O. (3)	O. 3	O. 3	O.
P. Thermodynamics	P.		P. (4)	P.	P.	P.	P. 6
Q. Controls	Q.	3	Q.	Q. (3)	Q.	Q.	Q. 3
R. Plant Layout	R.		R.	R. (3)	R.	R. 3	R. 3*
S. Mechanisms	S.		S.	S.	S.	S.	S. 4**
T. Safety	T.		T.	T.	T.	T. 3	T.
U. Electives	U.		U. (3)	U.	U. 12*	U. 18	U. 9, (11**)
V. Seminar-Projects	V.		V. (4)	V. (6)	V. 1	V.	V.
					*includes technical electives		* or **
PHYSICAL EDUCATION AND ROTC		*	(3) 2	*	2	4	2
A. Physical Education	A.		A. (3)	A.	A. 2	A. 4 or	A. 2
B. ROTC	B.		B.	B.	B.	B. 4	B.
OTHER NON-TECHNICAL COURSES		*	(16) 10 2/3	(6) 4	19	12	3
A. History	A.		A.	A.	A. 3	A.	A.
B. Health	B.		B.	B.	B. 1	B.	B.
C. Religion	C.		C.	C.	C. 14	C.	C.
D. Business	D.		D.	D.	D.	D.	D. 3
E. Management	E.		E. (3)	E.	E.	E. 6	E.
F. Supervision	F.		F.	F. (6)	F.	F. 3	F.
G. Electives	G.		G. (13)	G.	G.	G. 3	G.
OTHER COURSES		*					3
A. Electives	A.		A.	A.	A.	A.	A. 3
CO-OP WORK					3		
TOTAL		98	(192) 128	(163) 108 2/3	132	137	122
		*32 hours not listed		(*39) hours not listed			

TABLE II

C. MANUFACTURING (PRODUCTION) PROCESSES COURSE IDENTIFICATIONS

a. Manufacturing Processes and Materials
b. Manufacturing Processes - Metal Removal
c. Welding
d. Manufacturing Analysis - Organization
e. Production Tooling & Design
f. Metrology
g. Casting and Forming
h. Non-Traditional Production Processes
i. Machinability Theory
j. Jig and Fixture Design
k. Heat Treatment
l. Manufacturing Process - General
m. Manufacturing Seminar
n. Plastics Tooling

TABLE III

FREQUENCY RANKING OF COURSE WORK

Study Area	Frequency Ranking	Hours Minimum	Hours Maximum	Hours Average
MATHEMATICS		12	18.7	15.6
1. College Algebra & Trigonometry	6/6	3	6.7	4.8
2. Calculus	6/6	3	9	5.6
3. Computer	6/6	2	6	3.3
4. Statistics	2/6	2.7	3	2.9
5. Engineering Analysis and Problem Solving	2/6	2	3	2.5
6. Pre-Algebra and Trigonometry	1/6	3.3	3.3	3.3
BASIC SCIENCES		8	12.7	11
1. Physics	6/6	6	8	7.3
2. Chemistry	5/6	2.7	8	4.4
3. Life Sciences	1/6	2	2	2
WRITTEN AND ORAL COMMUNICATIONS		*	*	*
1. Composition (Assumed in each program)	6/6	2	6	3.5
2. Technical (Business) Writing	5/6	2	3	2.8
3. Speech	1/6	3	3	3
4. Literature	1/6	6	6	6
5. Seminar	1/6	1.3	1.3	1.3
HUMANITIES AND SOCIAL SCIENCES		*	*	*
1. Economics	4/6	3	4	3.3
2. History	3/6	3.3	6	5.1
3. Literature	2/6	2	3	2.5
4. Government	2/6	2	6	4
5. Psychology	2/6	2	3	2.5
6. Philosophy	1/6	4	4	4

TABLE III - Continued

Study Area	Frequency Ranking	Hours Minimum	Hours Maximum	Hours Average
TECHNICAL COURSES----------		57	71.3	65.7
1. Drafting (Graphics, Descriptive Geometry)	6/6	2	8.7	3.7
2. Manufacturing (Production) Processes		3	28	16.9
3. Statics-Mechanics	6/6	2	3	2.8
4. Electrical (Electronics, Instrumentation)	6/6	3	10.7	6
5. Materials-Metallurgy	5/6	3	8	5.2
6. Design (Tool, Machine, Jig & Fixture)	5/6	3	12	6
7. Quality Control (NDT)	5/6	2	6	3.4
8. Hydraulics (Fluid Power, Fluid Mechanics, Pneumatics)	4/6	2	3	2.5
9. Numerical Control	4/6	2	9	4.5
10. Strength of Materials	3/6	2.7	4	3.2
11. Dynamics	3/6	3	4	3.3
12. Methods, Motion and Time Study	3/6	2	3	2.7
13. Production Planning and Control	3/6	2	3	2.7
14. Controls	3/6	2	3	2.7
15. Plant Layout	3/6	2	3	2.7
16. Seminar and Projects	3/6	1	4	2.6
17. Manufacturing Management	2/6	3	3	3
18. Thermodynamics	2/6	2.7	6	4.3
19. General (Introduction)	1/6	1	1	1
20. Mechanisms	1/6	6	6	6
21. Safety	1/6	3	3	3
PHYSICAL EDUCATION AND ROTC----------		*	*	*
1. Physical Education	4/6	2	4	2.5
OTHER NON-TECHNICAL COURSES----------		*	*	*
1. Management	2/6	2	6	4
2. Supervision	2/6	3	4	3.5
3. History	1/6	3	3	3
4. Health	1/6	2	2	2
5. Religion	1/6	14	14	14
6. Business	1/6	3	3	3
CO-OP WORK	1/6	3	3	3

*No significant data available.

TABLE IV

TYPICAL MANUFACTURING (ENGINEERING) TECHNOLOGY
BACCALAUREATE DEGREE PROGRAM

COURSE WORK	COURSE WORK HOURS	AVERAGE TOTAL HOURS
MATHEMATICS		15-16
1. College algebra and trigonometry	4-5	
2. Calculus (including analytic geometry)	5-6	
3. Computer	3-4	
4. Other	0-3	
BASIC SCIENCES		11
1. Physics	7-8	
2. Chemistry	4-5	
WRITTEN AND ORAL COMMUNICATIONS		*
1. Composition	3-4	
2. Technical business writing	2-3	
3. Speech (subjectively added)	2-3	
HUMANITIES AND SOCIAL SCIENCES		*
1. Economics	3-4	
TECHNICAL COURSES		65-66
Strongly Recommended		
1. Drafting (Graphics, Descriptive Geometry)	3-4	
2. Manufacturing (Production) Processes	16-17	
3. Statics-Mechanics	2-3	
4. Electrical (Electronics, Instrumentation)	6	
5. Materials - Metallurgy	5-6	
6. Design (Tool, Machine, Jig & Fixture)	6	
7. Quality Control (NDT)	3-4	
Recommended		
1. Hydraulics (Fluid Power, Fluid Mechanics), Pneumatics	2-3	
2. Numerical Control	4-5	
3. Strength of Materials	3-4	
4. Dynamics	3-4	
5. Methods, Motion and Time Study	2-3	
6. Production Planning Control	2-3	
7. Controls	2-3	
8. Plant Layout	2-3	
9. Seminar and Projects	2-3	
Suggested		
1. Manufacturing Management	2-3	
2. Thermodynamics	2-3	
3. General Introduction Courses, Mechanisms	2-3	
4. Safety	2-3	
PHYSICAL EDUCATION AND ROTC		*
OTHER NON-TECHNICAL		*
CO-OP		*

*Insufficient data to indicate totals

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EDUCATION REPORT SERIES

INDEX TERMS

Manufacturing
Productivity
Education

MANUFACTURING PRODUCTIVITY CENTERS

By

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IIT Center
Chicago, Illinois

Presented at the
1980 SME Education Forum
April 30, 1980
Stouffer's Inn on the Square
Cleveland, Ohio

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SOCIETY OF MANUFACTURING ENGINEERS' EDUCATION DEPARTMENT ONE SME DRIVE P.O. BOX 930 DEARBORN MICHIGAN, 48128

Improving Productivity Through Manufacturing Education

ABSTRACT

The past decade has seen the United States fall from its position of eminence as a manufacturer of goods for the world. At present the United States is a net importer of manufactured goods. If the economic position of the nation is going to improve, U.S. manufacturing must improve to become more competitive in world markets. There are many facets to this problem, but the key is improvement in productivity in the United States. This must be one of our nation's major challenges. Education is an absolute necessity if this challenge is to be met, and the Society of Manufacturing Engineers (SME) is to be congratulated for taking a leadership position. The various actions underway to improve productivity are discussed, with special attention on the impact of education. An introduction to productivity is followed by a discussion of organizations striving to help.

PRODUCTIVITY - THE CHALLENGE

For all of the 20th Century, the United States has been the most productive nation in the world, producing more goods per person than any other major nation. As a nation, this level of productivity has earned for our people the comparatively high standard of living which we have come to expect. However, the preeminence of the United States in the area of productivity is being challenged. Figure 1 shows the Gross National Product (GNP) per employee history and projections for the industrial nations.

Based on these projections, France will catch up in 1986, Germany will catch up in 1987 and Japan in 1988, and unless something changes, the United States will soon be following instead of leading the major nations. These projections are based on real data, but remain projections - the actual point of catch up could vary significantly. The key point is that the other nations are catching up.

Productivity is a measuring of the efficiency with which capital, energy, technology, management and manpower are used. The optimum approach to productivity improvement can vary with time and place. For example, in an area of low salaries and limited capital resources, the optimum approach might be manpower intensive with only limited capital equipment. In a free market situation, the cost would be a direct measure of the productivity--the lower the cost and price, the better the productivity. There is a relatively free market in the United States, and the more productive company within an industry prospers over its less productive rivals. The international money market, exchange rates, tariffs and export incentives all cloud international price comparisons on a microscopic scale. On the microscopic scale, the balance of payments represents a good indication of relative productivity among nations.

96-951 O—82——16

At Currently-Projected Productivity Growth Rates, Four of our International Competitors Will Overtake U.S. in Production per Employee by or Before 1990

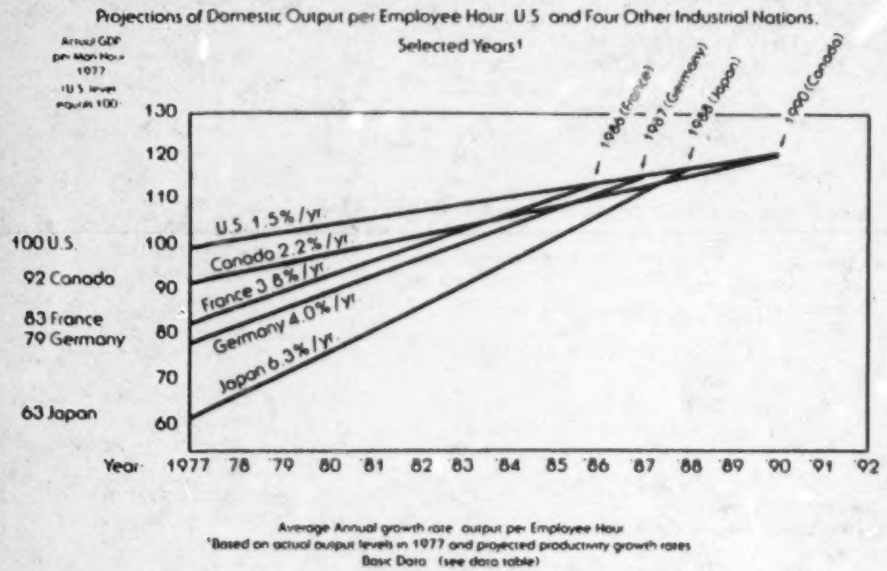


Figure 1

Philip Caldwell, President of the Ford Motor Company, in a recent talk stated "the United States has become an economic colony for much of the industrialized world, exporting agricultural products and raw materials, and importing manufactured goods. If we continue in that direction, we will not have the sinews for a vigorous well-balanced economy". United States balance of trade was a negative $36.1 billion in 1978--total exports of $136.9 billion with imports of $173.0 billion. If it were not for a positive agricultural balance of trade the trade deficit would have exceeded $50 billion.

The productivity crisis is not new - the problem has been reported for many years. Since productivity is relatively difficult to measure, most measurements of productivity have, in fact, measured productivity changes, Figure 2 shows the change in productivity for the industrial nations over the past decade. Only in the United Kingdom has there been a productivity improvement as limited as that of the United States. Canada is considerably better and the major industrial nations of Europe have done much better. If the changes in productivity over months, quarters, or even years are compared, the data can be clouded by local short term conditions. The use of changes over a decade eliminates this and the comparisons are realistic.

The data shown in Figure 2 explain the cacch up illustrated in Figure 1.

MANUFACTURING PRODUCTIVITY INCREASES
OUTPUT PER HOUR 1967-1977

Nation	Percent Increase
United States	27
United Kingdom	27
Canada	46
Italy	67
West Germany	70
France	75
Japan	99

Source: Burear of Labor Statistics

Figure 2

Manufacturing is the backbone of the United States economy contributing $1490 billion to the $2109.6 billion 1978 GNP. Since 70% of the GNP is generated by manufacturing, it is not really necessary to justify the importance of manufacturing. Over the past decade, the U.S. manufacturing sector has lost its world eminence. In 1978, the United States was a net importer of manufactured goods--$8 billion more manufactured goods were imported than were exported. If the United States is to remain a first class nation, it is necessary to improve the performance of the manufacturing sector.

United States manufacturers must compete sucessfully in world markets. If a U.S. industry cannot compete with a foreign manufacturer in the world market, it is only a matter of time until that industry will be challenged for the U.S. market. At that stage, the U.S. industry is "on the ropes with an international competitor" who has already demonstrated superiority. The industry may go down fighting (e.g., black and white televisions), may obtain governmental protection or help (e.g., the trigger price approach for steel and the program directed to help the shoe industry) or take an alternate approach.

Playing catch up is expensive and will result in the United States losing at least segments in most of the challenged industries. The role of education can hardly be overemphasized in this task. For too long manufacturing has been considered the technical stepchild.

The bright engineers have been directed toward research and development through work assignments. The research community gets the best students leaving the rest to do the engineering. Those in charge of engineers repeat this process, leaving those not up to their standards to manufacturing firms. As this writer's management role has followed the progression from

research and development to engineering, and then to manufacturing, the result has been frustrating. Our educational system has encouraged this pecking order and it is with pleasure that some noticeable major improvements are being led by SME.

DESCRIPTION OF THE MANUFACTURING PRODUCTIVITY CENTER

IIT Center is a collection of organizations located on the near south side of Chicago. There are over 2500 people employed at IIT Center and over 8000 students doing graduate and undergraduate work. Principal organizations at IIT Center are:

- Illinois Institute of Technology (IIT)
- IIT Research Institute (IITRI)
- Institute of Gas Technology (IGT)
- John Crerar Library
- American Association of Railroads (AAR) Research Laboratory
- Gas Development Corporation (GDC)
- Gas Research Institute (GRI)

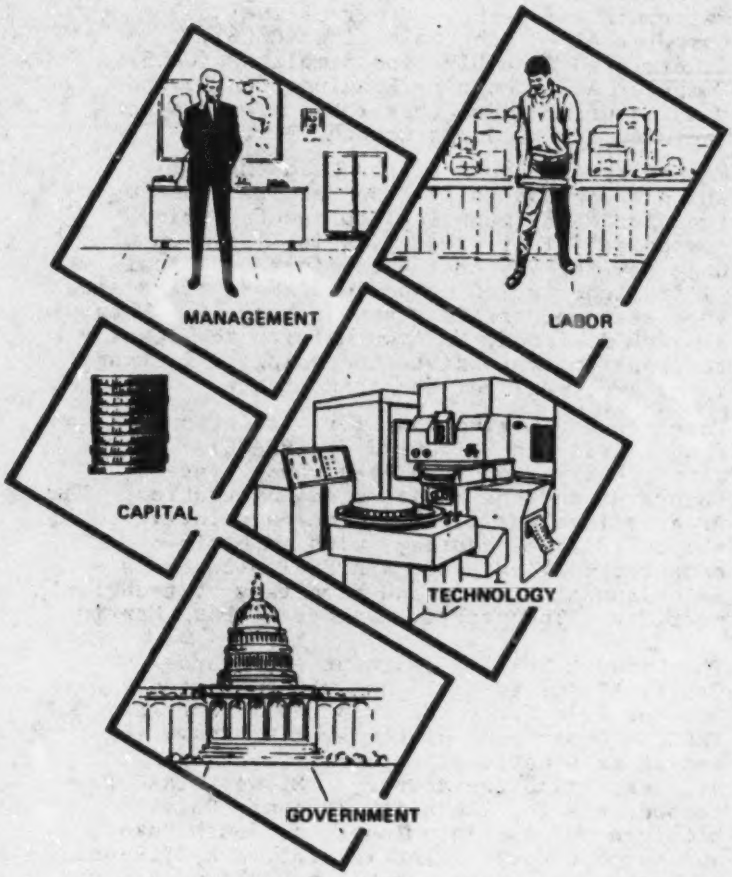
As a collection of technology oriented organizations located in Chicago, IIT Center has always been responsive to industry. Early in 1977, industry leaders made it clear to IIT Center that they considered productivity to be the major challenge of the next decade and they suggested that IIT Center do something to help industry improve productivity.

IIT Center reviewed this suggestion and concluded that the greatest impact could be made by concentrating on manufacturing productivity. In September 1977, the formation of the Manufacturing Productivity Center (MPC) was announced. MPC is an umbrella organization over all of the IIT Center with IITRI and IIT providing the lead.

IIT Center has had a strong leadership role in manufacturing technology; so there was a core of activities to support MPC. We have over 200 people involved in directly relevant areas with external support exceeding $5,000,000 annually. Additionally, there are several hundred staff members working in related areas such as mechanical design, environmental safety and health, and engineering. With this base of knowledge, MPC has the information and contacts which can help improve productivity.

The range of MPC interest is demonstrated by the logo. Management, technology, labor, capital and government all affect manufacturing. These influences must be considered in any program designed to increase the productivity of the manufacturing sector. MPC further views its charter to include

all aspects of the manufacturing operation. If a factor is part of or influences manufacturing, it is part of the manufacturing system.



MPC ACTIVITIES

Under the MPC umbrella, work is underway for numerous government agencies and industrial corporations. Work done for corporation is done on a proprietary basis so only the customer has access to the results. A few of the general interest programs underway within MPC are described.

- Advanced Manufacturing Methods (AMM) is a multiclient industrial program which has been ongoing for 18 years. The program has developed and maintains a series of computerized tools to aid in scheduling materials and works. Programs include Computer Aided Line Balancing (CALB); Generalized Assembly Line Simulator (GALS); Computer Aided Machine Loading (CAMEL) and Manufacturing Simulators (MS). The project engineer is Dr. Janis Church.

- Manufacturing Applications Team (MATeam) which is sponsored by NASA has its goal to transfer NASA technology to manufacturing companies. This program, which has been underway for 4 years, determines technical limitations facing companies. NASA files are then searched for relevant technology. When a match is found, NASA works with the company to transfer appropriate technology. Ed Bangs is project engineer for this effort.

- Research and Engineering for Automation and Productivity in Shipbuilding (REAPS). REAPS is currently supported by seven private shipyards and the Maritime Administration. The program involves various studies relative to shipbuilding technology, with emphasis on computer application. REAPS also conducts a major annual meeting and a variety of technical meetings. The program manager is Doug Martin.

- The Midwest Trade Adjustment Assistance Center (TAAC) is a program which started October 1978 for trade impacted industries. TAAC, a Department of Commerce program, is set up as a national activity with 10 TAAC offices around the country. Midwest TAAC is responsible for Illinois, Indiana, Ohio, Michigan, Wisconsin, Minnesota, South Dakota and North Dakota. TAAC is staffed by financial analysts and business advisors, who work with companies to establish their eligibility. Subsequently, technical help is supplied as needed. Bill Fillman serves as program manager for the Midwest TAAC.

With the exception of TAAC, all of the above programs were ongoing when MPC was organized. Since its formation, MPC has initiated a number of activities including:

- Manufacturing Productivity Frontiers--a monthly journal first published in September 1977. Frontiers contain original articles, reviews of

meetings and other sources, abstracts of productivity related papers, lists of productivity meetings, etc. Sample copies are available upon request and the subscription rate is $100 annually.

- Technical Meetings are arranged by MPC itself or in cooperation with other organizations.
- MPC has helped initiate greater emphasis on manufacturing productivity training at IIT. A few courses have been initiated and several more planned. One of the more interesting approaches is a course on Modern Manufacturing Methods being conducted by Dr. Rollin Dix. Eight experts have taught 1 or 2 weeks each, giving the students expert input in a classroom setting.
- MPC has a membership activity for companies interested in manufacturing productivity. There are currently 13 member companies. Quarterly meetings for members only are held. Members receive Frontiers, information retrieval, registration at meetings, limited consulting and similar services. Half of the annual registration fee is used for specific studies for the member companies either individually or as a collective activity.
- MPC has been actively involved in trying to forge a national productivity effort. We interacted with the National Center for Productivity and Quality of Working Life (NCPQWL). Since the Center demise, MPC has been involved in the ongoing attempts to develop a network between the private productivity centers.

MPC is dedicated to helping United States industry increase its productivity. MPC will make information available to industry and, through MPC, will encourage interaction among companies to increase their productivity and further help to increase the productivity of vendors and material suppliers serving other industries. Productivity is the responsibility of individual companies--they succeed or fail based on their own success. The Center provides participants with information and motivation to give them an advantage. MPC has strength in knowledge and technology relating to manufacturing productivity and this is the area which MPC serves. MPC is trying to maximize its overall contribution through interaction with other productivity centers and with individuals having an interest in productivity.

INTERACTION OF PRODUCTIVITY CENTERS

With the demise of the NCPQWL in October 1978, government leadership of the productivity movement disappeared. Demonstrating "class", the National Productivity Center hosted a meeting of the private productivity centers at the Smithsonian Institution in September 1978. This Association is still informal and loose, but has been of considerable value. Meetings to date have been:

Date	Host	Location
September 1978	NCPQWL	Washington, D.C.
March 1979	Georgia Productivity Center	Atlanta, Georgia
October 1979	Manufacturing Productivity Center	Chicago, Illinois
March 1980	Oklahoma State University	Tulsa, Oklahoma

This network has provided for a degree of communication and cooperation between the centers. The centers each have a different focus and different charters. A list compiled in fall 1978 by the NCPQWL is quoted geographically in Table 1. There are several more and some of those listed are relatively dormant. For the purpose of this presentation, we want to note two other activities which are particularly relevant to manufacturing and education:

- Massachusetts Institute of Technology Laboratory for Manufacturing and Productivity under Dr. Nam Suh.
- Rensselaer Polytechnic Institute Manufacturing Center recently organized by Dr. George Antell.

CENTERS AND EDUCATION

Many of the productivity centers are associated with universities and presumably these contribute to the educational program. Less than 10 of the productivity centers are technically oriented so this interaction is limited. A number of other universities have had manufacturing programs and more are establishing such programs. A word of caution here--the simple addition of one or two manufacturing courses to an existing engineering program does no harm, but also does little to change the program. If it is manufacturing we want to teach, we should do it throughout the educational program. To do this effectively, academically-oriented teachers who have real industrial experience must be found.

TABLE 1: GEOGRAPHICAL INDEX OF U.S. PRODUCTIVITY AND QUALITY OF WORKING LIFE CENTERS

ALABAMA	CENTER FOR GOVERNMENT AND PUBLIC AFFAIRS Auburn University at Montgomery Montgomery, AL 36117
ARIZONA	PRODUCTIVITY INSTITUTE College of Business Administration Arizona State University, Tempe, AZ 85281
CALIFORNIA	CENTER FOR QUALITY OF WORKING LIFE Institute of Industrial Relations, University of California 405 Hilgard Avenue, Los Angeles, CA 90024
	THE PRODUCTIVITY COUNCIL OF THE SOUTHWEST STF 124, 5151 State University Drive Los Angeles, CA 90032
FLORIDA	SOUTH FLORIDA PRODUCTIVITY CENTER New World Center Campus, Room 1402 300 N.E. Second Avenue, Miami, FL 33101
GEORGIA	COMMITTEE ON PRODUCTIVITY American Institute of Industrial Engineers 25 Technology Park, Norcross, GA 30092
	GEORGIA PRODUCTIVITY CENTER Engineering Experiment Station Georgia Institute of Technology, Atlanta, GA 30332
ILLINOIS	MANUFACTURING PRODUCTIVITY CENTER IIT Center 10 West 35th Street, Chicago, IL 60616
	PRODUCTIVITY CENTER Graduate School of Business Northwestern University, Evanston, IL 60201
	QUALITY OF WORKING LIFE PROGRAM Institute of Labor and Industrial Relations University of Illinois at Urbana-Champaign 540 East Armory Avenue, Champaign, IL 61820
INDIANA	PURDUE PRODUCTIVITY CENTER School of Industrial Engineering, Purdue University Grisson Hall, West Lafayette, IN 49707
MARYLAND	MARYLAND CENTER FOR PRODUCTIVITY AND QUALITY OF WORKING LIFE College of Business and Management University of Maryland, College Park, MD 20742
MASSACHUSETTS	MASSACHUSETTS QUALITY OF WORKING LIFE CENTER 14 Beacon Street, Suite 712 Boston, MA 02108
MICHIGAN	QUALITY OF WORK LIFE PROGRAM c/o Wayne State University, Office of Urban Affairs 1072 Mackenzie Hall, Detroit, MI 48106

TABLE 1 (concluded)

NEW YORK	CENTER FOR PRODUCTIVE PUBLIC MANAGEMENT John Jay College of Criminal Justice City University of New York 445 West 59th Street, New York, NY 10019
	WORK IN AMERICA INSTITUTE, INC. 700 White Plains Road Scarsdale, NY 10583
NORTH CAROLINA	MDC, INC. 137 East Rosemary Street, Post Office Box 1057 Chapel Hill, NC 27514
	PRODUCTIVITY RESEARCH AND EXTENSION PROGRAM North Carolina State University P.O. Box 5511, Raleigh, NC 27607
OHIO	QUALITY OF WORKING LIFE PROGRAM Center for Human Resource Research The Ohio State University, Suite 585 1375 Perry Street, Columbus, OH 43201
OKLAHOMA	OKLAHOMA PRODUCTIVITY INSTITUTE School of Industrial Engineering and Management Oklahoma State University, Stillwater, OK 74074
PENNYSLVANIA	MANAGEMENT AND BEHAVIORAL SCIENCE CENTER Wharton School, University of Pennsylvania Vance Hall, 3788 Spruce Street, Philadelphia, PA 19104
	PENNTAP Pennsylvania Technical Assistance Program J. Orvis Keller Building, Pennsylvania State University University Park, PA 16802
	QUALITY OF WORK LIFE CENTER FOR CENTRAL PENNSYLVANIA Pennsylvania State University Capitol Campus, Middletown, PA 17057
TEXAS	AMERICAN PRODUCTIVITY CENTER 1700 West Loop South Houston, TX 77027
UTAH	UTAH STATE UNIVERSITY CENTER FOR PRODUCTIVITY AND QUALITY OF WORKING LIFE UMC 35, Utah State University, Logan, UT 84321
WASHINGTON, D.C.	AMERICAN CENTER FOR THE QUALITY OF WORK LIFE 3301 New Mexico Avenue, N.W. Suite 202 Washington, D.C. 20016
	HARVARD PROJECT ON TECHNOLOGY, WORK, AND CHARACTER 1710 Connecticut Avenue, NW Washington, D.C. 20009
PUERTO RICO	INSTITUTE FOR PRODUCTIVITY 592 De Hostos Avenue, Baldrich Hato Ray, Puerto Rico 00918

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EDUCATION REPORT SERIES

INDEX TERMS

Education
Productivity
Training

TRAINING FOR PRODUCTIVITY IMPROVEMENT

By

Robert Hoogstoel
Manager
Technical Education
Dana University -- Dana Corporation
Toledo, Ohio

Presented at the
1980 SME Education Forum
April 30, 1980
Stouffer's Inn on the Square
Cleveland, Ohio

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SOCIETY OF
MANUFACTURING
ENGINEERS'
EDUCATION
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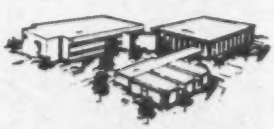

Improving Productivity Through Manufacturing Education

ABSTRACT

Productivity improvement happens when people who are aware of a problem have the knowledge to fix it and can do it because the climate allows it. Dana Corporation's training focuses on awareness, knowledge and climate to improve the rate of productivity growth.

THE PRODUCTIVITY MOMENT

Productivity improvement happens in a moment of change - change in a habit; change in a method; change in a point of view; change in an organization.

In a company so large and geographically widespread as Dana Corporation, with sales approaching three billion dollars annually, productivity improvement doesn't happen in a few moments of dramatic gain; it happens in many moments of small gain, in factories and offices throughout the company. In Fort Wayne, a production supervisor takes time to train his machine operators how to get more pieces from each carbide insert; in Toledo, the quality control manager decides to reorganize inspection, reducing machining scrap and overall manufacturing cost; in Thorold, an inquisitive engineer, seeking to improve heat treating capacity discovers that an entire heat treat procedure can be eliminated.

Some change happens by itself; but constructive changes like these require the management and training of everyone involved. At Dana, the effort to improve productivity is pervasive and continuous. All training is directed toward the goal of productivity improvement, improvement at a rate which exceeds our competition and which gives us a fighting chance against inflation.

THE THREE KEYS

Training for productivity improvement addresses three key elements - awareness, knowledge, and climate. Look at this snapshot of a moment of productivity opportunity and see how these elements combine to improve productivity and point the way to a training strategy. That's Gilbert on the left. He performs a finishing operation on a part just prior to assembly. He's a hard worker and conscientious. On the right is McBride, Gilbert's supervisor. McBride has been watching Gilbert work and thinks that by reorganizing the job, Gilbert could be more productive, that is, put out more pieces.

McBride hesitates: "How can I ask Gilbert to speed up when he always keeps up with assembly?" And "What incentive does Gilbert have to speed up now that he's on straight salary?"

These two men have the opportunity to collaborate to boost productivity in a direct way. What happens next will determine whether this opportunity is capitalized or wasted.

Awareness brought us to this moment. Knowledge and climate will carry us out of it.

First awareness. McBride was aware that productivity improvement is a Dana goal. He was aware that the shop is full of opportunities for him to find. He was aware that Gilbert's operation was one of those opportunities. He was also aware that his idea must come to life through Gilbert's work and that if it was to happen, he, McBride, must make the first move. And, of course, he was aware of some obstacles.

Having an itch is one thing; scratching it is another. Scratching this itch requires knowledge, especially of job design and of Gilbert's psychology. It also requires a climate in which McBride and Gilbert can work cooperatively and constructively to make the most of this opportunity.

Each instance of awareness, knowledge, and climate represents a training opportunity - even an obligation - for us. Please note that when I say "training" I don't necessarily mean "that which is done in the training department". I mean it in a far broader sense. McBride's awareness was trained into him through experience and

the shop floor, by his peers, his supervisors and through a variety of classroom activity, both within and outside Dana. He gained his knowledge through the same sort of training.

Climate results from a special sort of training. In a plant, the plant manager is the principal trainer. By his or her day to day conduct, relationships - both formal and informal - whether conscious of it or not, he or she trains the people to an attitude which is the climate of the plant. When that is an attitude of mutual trust, improvements may happen; without trust, improvement is less likely. In this case, everything was right. Gilbert and McBride cooperated to time the job then redesign and retime it. Without working harder, Gilbert improved his output by 70%, leaving him free part of the day to make another contribution to the productivity of the plant.

The point is this. Productivity improvement can happen when awareness, knowledge, and climate combine in a moment of opportunity. All of these elements must be consciously addressed by training, formal or otherwise, to maximize the probability that these moments happen and that each of them unfolds positively.

TRAINING AT DANA

Here are some highlights of Dana's program of training for productivity improvement, starting with climate.

In 1969, an 8½ x 11" sheet of paper, simply titled "Policies", replaced two volumes of policies and procedures. Red tape was cut wholesale the moment the policy sheet appeared, and office productivity began to rise throughout Dana. This sheet is also a training device. It's implicit lesson to all of us is: "Keep it simple and direct".

We communicate goals, objectives, news, results and performance in a timely way, up, down and sideways, using means both formal and informal. We discourage secrets and the hoarding of useful information.

We believe that the person doing a job knows more about that job than anyone, including the boss. So we want his or her ideas for improving productivity on that job.

A recent advertisement put it this way: "Talk back to the boss." And judging from the number of copies of that ad I've seen posted in offices and shops around the company, the boss won't forget that.

We believe that each of us has an obligation to train himself. Another of our recent ads puts it more bluntly: "The only dumb questions are the ones you don't ask".

DANA UNIVERSITY

Our in-house training division is called Dana University. It is one of the formal means of promulgating a corporate climate. It is also the most prominent mechanism for dealing with awareness and knowledge.

Dana U approaches training on five fronts:

First, Regional Programs help people in the plants organize training classes for their own sake. Every available local resource is tapped - schools, community colleges, private individuals - to present training in any subject which finds a market. The near term goal is to help people learn to learn - anything. In the long term, these programs will focus on job related subjects to directly improve productivity.

Second, educational resources ferrets out outside resources - seminars, films, books, videotapes, lectures- of possible interest in Dana's quest to improve productivity and publicizes them within the company.

Third, the Business School, where most of our formal classroom training happens, conducts classes in Toledo and in plant cities on business related subjects - Cost Control, Asset Management, Materials Management - and management and supervisory skills aimed at improving productivity. Last year, 2,500 person weeks of training were generated in this area.

Fourth, two masters' degree programs - one in mechanical engineering, another in business administration - are conducted by Toledo University and Bowling Green State University, respectively, on the Dana premises. Twice a year, two courses in each program are compressed into two intensive weeks of classroom presentation. Some homework is completed during the two weeks but major

projects are done at home and mailed in by semesters' end. Participants can earn the master's degree in three calender years. This is a solution to the problem of maintaining technical and managerial vitality among people faced with unanticipated transfers or who are located far from a university. We've already seen specific tools and techniques learned in these classes put to work to improve productivity.

THE TECHNICAL SCHOOL - MANUFACTURING PRODUCTIVITY

This brings us finally to the fifth front, addressed by the Technical School, to which I belong. We focus on technical subjects. Our first priority is to improve manufacturing productivity by improving the skills of our manufacturing engineers - all the people who design, process, schedule, test, inspect or supervise the manufacture of our products, as well as those responsible for the design, construction or maintenance of facilities to do the manufacturing. Especially important is the production supervisor, who is involved with every productivity improvement and who ultimately implements many of them.

Our goal is to supplement the knowledge that qualified them for their jobs, to help them improve productivity in the area they can influence.

We believe the training is most effective when it relates directly to their problems, so we prefer, where possible, to do the training on-site, to groups of people who work together.

Because our plants are many and we are few, we aim to make plants independent of us by including, as a part of the training, the preparation of someone in the plant to carry on the work when our training is done. To amplify the effects of this technical training, we are preparing to help production supervisors expand their skills of job instruction so they may effectively train production machine operators to implement new ideas where the tool hits the steel.

Let me illustrate. We decided that the fundamentals of statistical quality control are important to all manufacturing engineers. With the help of a committee of quality control managers, we designed a one week course which we give centrally every couple of months. In that centralized form, we can reach, say 100 persons per year,

scattered throughout the company. Because of the expense of attending, the audience is select, and each returns to his or her plant alone, with the burden of introducing new ideas which they only partially grasp. In the struggle between the promising but half-understood new idea and the less potent but familiar one, the new idea hasn't a chance.

Now, take a piece of that same course - say, evaluating machine capability from a statistical sample. Present it at a plant, relating the material directly to machines and processes in that plant. Do it in short segments or on Saturday so everyone who wants to can attend, and invite everyone. Have you heard of the power of an idea whose time has come? The first time we did this at a small plant, thirteen people, including the entire quality control staff, some supervisors and some machine operators volunteered to attend on their own time - seven hours on a Saturday. On Monday, the Q.C. staff began a systematic review of machine capabilities throughout the plant. And the Q.C. manager is prepared to present the material next time he wants to offer it. This is what we mean when we speak of training for productivity improvement.

Value analysis is another topic which can help boost productivity. After holding a couple of centrallized seminars, we are working at the division level to bring these ideas directly to the workplace.

There are certain topics which appeal to small, specific segments of the Dana population. From time to time, we present a centrallized seminar on such a topic, using carefully selected outside experts. Examples are cutting fluid selection and treatment, health and safety in the workplace, gear noise analysis and energy conservation.

That's not the full extent of our activity in the Technical School, but it gives the general idea of it.

SUMMARY

To summarize, whether it's in the shop or in the office, we at Dana are training our people to be aware that productivity improvement is a goal and to know what productivity is and how to improve it. And we train the entire organization to provide a climate that encourages constructive change. To us, this is what training for productivity improvement means, because in this way, we'll create more and more of those moments of opportunity and be sure that more and more of them yield gains of the sort that McBride and Gilbert realized when they got their heads together.

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ER80 - 06

EDUCATION REPORT SERIES

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Education
Manufacturing
Productivity

INCREASING THE CONTRIBUTION OF MANUFACTURING EDUCATION TO PRODUCTIVITY IN THE UNITED STATES

By

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and

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National Research Council
Washington, D.C.

Presented at the
1980 SME Education Forum
April 30, 1980
Stouffer's Inn on the Square
Cleveland, Ohio

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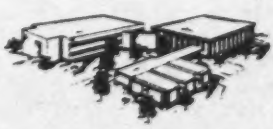

Improving Productivity Through Manufacturing Education

INCREASING THE CONTRIBUTION OF MANUFACTURING EDUCATION TO PRODUCTIVITY IN THE UNITED STATES

Dr. H. Guyford Stever
and
Dr. Joel D. Goldhar

Society of Manufacturing Engineers/Education Forum
Cleveland, Ohio

April 30, 1980

The issue of manufacturing education and its improvement as a strategy for productivity enhancement in the United States is a timely one and, I hope, will be the focus of considerable attention in the professional societies, industrial firms, government agencies and the universities. The combined, coordinated and focused efforts of all these institutions will be required if education is to have any impact at all, within a reasonable time span, on the productivity of U.S. industry.

We have a long history of partial, fragmented and isolated linkage between and among these institutions, but their results, while beneficial, have also been partial, fragmented and isolated with insufficient cumulation, replication, or diffusion of the useful results. While these prior--and many existing--linkages illustrate the feasibility of such efforts, the scale and scope needed for national impact will require far greater commitments, a focused national leadership, and a willingness on the part of each participant to avoid suboptimization--to give up some of the short term benefits available to their individual organization in favor of greater long term benefits to the economy and society as a whole. Our history

suggests that this will not be easy and usually only happens in time of national emergency. Clearly we need to recognize the productivity issue and the problem of U.S. competitiveness with other countries' industry as a national emergency--perhaps as important and far-reaching in its implications as the "energy crisis."

Let us, for a moment, reexamine the context within which manufacturing education must advance. Among the negative factors are:

1. The low status of manufacturing and manufacturing engineering in both industry and universities. This is reflected in low salary scales, little academic focus, and a low level of government support for R & D in manufacturing.

2. A low level of investment in productivity improving technology--i.e., not enough "demand pull" for manufacturing education. This is particularly true in the smaller firm and many non-defense related industries and is exacerbated by inflation and the high cost of capital.

3. A short-term, "fire-fighting" mode of operation in most manufacturing companies--compounded by long lead times for new process technology and critical purchased components--and complicated by rapidly changing markets and product designs.

4. The lack of a federal government policy on manufacturing and productivity--the lack of even a focal point for the discussion

of manufacturing issues which transcend the scope and responsibilities of individual agencies and congressional committees. There is a failure to recognize the full complexity of manufacturing issues.

On the other hand, we can see some very positive factors which make the early 1980s an auspicious time for action and a new commitment to manufacturing education:

1). An increased level and more universal recognition of the productivity problem and the role of manufacturing in its solution. This is seen in the President's order to the NSF and the new Department of Education for an assessment of the health of science and engineering education. This study effort clearly recognizes the special shortage of engineers trained in computer-augmented design and manufacturing techniques. We are also seeing a wide variety of other specific activities at various agencies, universities, and firms, as I mentioned earlier, and considerable media attention to both productivity and manufacturing.

2). The underlying "science base" for manufacturing is expanding rapidly with contributors from materials science, information systems and computer engineering, mechanical engineering, electronics, systems engineering, operations research, industrial engineering, and the social and management sciences.

What is needed is a focus on integration and synthesis and the development of a discipline of "manufacturing science" to bridge the gap between research in the basic disciplines and application to specific problem areas in manufacturing.

3). The quality and sophistication of our manufacturing technology have taken a discontinuous leap ahead in recent years. Computers and microprocessors, lasers, and new materials have led to robots, smart machine tools, and efficient information and control systems; with high potential for major reductions in inventory levels and unit costs, faster throughputs and reduced lead/turnaround times, and the design of manufacturing systems which offer marketing, organizational, and strategic options not possible with more traditional technology. Alvin Tuffler's new book, THE THIRD WAVE, points out that we are in the process of moving from "second wave" manufacturing characterized by long runs of standardized identical products to the "third wave" of manufacturing dominated by short runs of partially, or completely, customized products. This third wave is made possible by the new manufacturing technologies and offers great potential for increasing U.S. industry's competitiveness in world markets.

But these changes do not come easily and a more sophisticated manufacturing engineering and management is required to

implement these new systems and to derive full benefit from the advances in science and engineering applicable to manufacturing. The next generation of manufacturing engineers must be trained in the fundamentals of science as well as the traditions of manufacturing.

4). A gradual, even if sometimes grudging, recognition of the importance and legitimacy of manufacturing as a field of study in the universities and government funding agencies, coupled with a recognition on the part of industry that the universities--and basic science and engineering--have important contributions to make to the solution of their practical problems. Manufacturing science and engineering is on the brink of full professionalization--a long overdue event. And, I should add, an event which has been made possible in large measure by the continued efforts of the Society of Manufacturing Engineers.

How shall we respond to the opportunity I have outlined above? Let me first report to you on the activities of my own organization and then offer some recommendations for action by others.

Growing out of our positive experiences with the Air Force supported Committee on Computer-Aided Manufacturing and its relationship with the ICAM Program, the Assembly of Engineering of the National Research Council has established a Manufacturing Studies Board. This Board will be

responsible for stimulating and coordinating a wide range of technological, human, and public policy issues in manufacturing and productivity. The initial organizing meeting will take place in early May and is being supported by a start-up grant from the SME. The Board is currently seeking stable sources of financial support and as soon as possible will announce its agenda and priorities. I expect that the Board will serve as a focal point for at least informal coordination of national issues and policies in manufacturing and productivity and a stimulus to interaction and communication among government, industry, and academia.

Let me finish up with some recommendations to all three sectors that might help--as the title I was assigned suggests--to increase the contribution of manufacturing education to productivity in the United States.

1. To the Universities--Do it! Establish departments devoted to research and teaching in manufacturing, not interdepartmental committees or centers where turf battles must constantly be fought, but complete departments with tenured faculty positions and stable financial support.

2. To Industry--Help the universities. They will need money, equipment and expertise. Manufacturing education will be very expensive education, but there will be economies of scale in university based efforts supported by many firms.

3. To the Government-Funding Agencies - Increase and focus the

available financial support to manufacturing research and development as well as education and training. We need innovation in teaching techniques as much as we do in the technology for manufacturing. This governmental support will make Recommendations 1 and 2 possible.

4. To the professional societies--not just the SME--work to improve the status and recognition of manufacturing and manufacturing engineering as a legitimate discipline and act as the lubricant in the coming interactions among universities, government, and industry.

5. To all of the potential participants in this endeavor--don't waste time. The window of opportunity when the need is clear and the science is ready will not be open forever. The time to act is now. Leadership can and must come from many different sources. The Assembly of Engineering will do its part but cannot have an impact in a vacuum. I invite all of you to participate with us in the work of the Manufacturing Studies Board and to initiate your own actions and to invite us to assist and participate wherever we can.

EDUCATION REPORT SERIES ER80 - 08

INDEX TERMS

Careers

Manufacturing Engineering

CAREER INFLUENCE SURVEY REPORT - OCTOBER 1979

By

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ABSTRACT

A survey was conducted to determine the factors that influenced college students to select their technical major field of study. The college students surveyed were majoring in 17 different technical areas and were asked questions which centered on five possible areas of influence including: career counseling, family friends and neighbors, teacher advice, student self analysis, and 18 general sources of information. The survey was used to determine the emphasis of an SME career guidance program.

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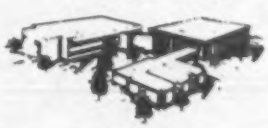

Improving Productivity Through Manufacturing Education

CAREER INFLUENCE SURVEY REPORT
OCTOBER 1979

In an effort to meet an assignment to update the current guidelines of SME in career guidance, the factors that influence young people in making a career choice, seemed an excellent starting point. To proceed with recommendations that omit this consideration would be to ignore the fact that today's youth are allowed to make most of their own career choices. If the information of student influence is combined with the job needs of employers and educational requirements of schools, the essential elements of a career guidance investigation would be in place.

The lack of available survey information for students in technical endeavors prompted us to develop a questionnaire and seek our own information. (Appendix A) The futile search for information also suggested that other career investigations were made either without considering student input or by assuming what student preferences and influences would be. The need for such information is considered important. If for example, we found that a significant amount of students felt that they received adequate career guidance in engineering and technology in High School, it would have a limiting effect on the emphasis SME would need to give to this subject.

Rather than select student majors from a specific engineering discipline, we desired a survey that would cover a wide variety of technical interests. The SME approach to

career guidance of high-school-age youth is to push engineering in general rather than specialize in Manufacturing. Fortunately, Western Michigan University, School of Applied Science, had such a variety in its classes and permission was obtained to contact them. The survey was completed as (317) students responded to (45) different questions. The surveyed population were majoring in (17) different technical areas. These include:

1. Engineering Graphics
2. Building Construction Supervision & Management
3. Manufacturing Administration
4. Mechanical Engineering
5. Metallurgy
6. Aviation Technology Management
7. Industrial Engineering
8. Paper Engineering
9. Flight Technology
10. Computer Systems Engineering
11. Aircraft Engineering
12. Automotive Engineering
13. Industrial Drafting Technology
14. Industrial Technology
15. Electrical Engineering
16. Mathematics
17. Masters in Technology

Questions asked centered on five possible areas of influence. They included: Career Counseling, Family Friends and Neighbors, Teacher Advice, Student Self Analysis, and Eighteen General Sources of Information. Respondents were also asked to list any other sources of influence they wished that were not included in the Questionnaire.

CAREER COUNSELING

Eight questions on the questionnaire dealt with the contribution of school counseling departments and covered levels from Junior High School to Four Year Universities. Only 8% remembered being exposed to career counseling in Junior High and the figure increased only to 30% in High School. Community Colleges and Universities must have assumed the career guidance task was completed earlier, as they had similar low percentages. Nineteen percent of the total population surveyed felt that this counseling had influenced their career choice. It also did not seem that respondents considered aptitude testing effective to career guidance. Although 86% received such evaluations in Junior and Senior High Schools, only 23% felt this methcd influenced career choices.

Conclusions relating to career guidance counseling are impressive by their lack of effectiveness and the proportionately small quantity that recalled receiving it.

FAMILY, FRIENDS AND NEIGHBORS

These sources influenced 96% of the students with the family receiving 53%. The father is by far the overwhelming member for influence. The only significant percentage other than the father was the contribution of both parents. Major types of advice included interest, ability, security, and money. "Can always find a good job in industry", "Good future and good money", "You are mechanically minded and can think out problems", "Your field is interesting", "I like the field and so will you", "Study a lot and you will get ahead", "Do your best if you want to get anywhere", "Get a degree", "No jobs in Liberal Arts so stay in Applied Science", "Do what ever makes you happy but go for the money".

TEACHERS ADVICE (Junior High through University)

High School and University teachers seem to have had the most influence among teachers, although the percentage that received and used this advice was low, 28%. The subjects themselves seemed to have had more influence. Students listed (88) different course subjects that influencing teachers taught. The five with the greatest repeatability were:

1. Math at 40%
2. Physics at 23%
3. Drafting at 16%
4. Chemistry at 11%
5. Applied Science at 10%

INFLUENCE OF STUDENT SELF ANALYSIS

The strongest indication from this survey is that students surveyed had made self comparisons of their ability and interest in the subject matter of their career curricular choices. It also seems to indicate a mature seriousness of purpose that may not have been anticipated: 85% were interested in problem solving that produced visable results, 89% enjoyed problem solving that utilized mental and handwork together. Math competency influenced 60% but working with science problems that included Math, interested 66%. Designing or getting idea forms on paper influenced 76% but computer applications were not as high as expected, at 44%.

OTHER SOURCES OF INFLUENCE

In this category eighteen activities ranging from Boy Scouts to reading magazines were listed. Students were to indicate if any of the items had a career influence on them. Items that impressed 25% or more students are listed below:

1. Job Forecast Information-46%
2. Undergraduate Catalog-32%
3. Magazines, Catalogs-29%
4. Museum of Science and Industry-27%
5. University or College Visit-27%
6. Career Guidance Literature-25%
7. Newspaper Want Ads-25%

CONCLUSION

This survey clearly indicated that the schools previously attended by the respondents were in need of effective career guidance. On the assumption that this condition may exist on a national basis, we proceeded to search for career guidance programs for Junior and Senior High Schools. Programs that would be effective in introducing and promoting engineering type education.

EDUCATION REPORT SERIES

SME

1981

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ER81-02

CAD/CAM—The Computer Invasion of Engineering and Manufacturing

abstract

Talk states that Computer Aided Engineering/Computer Aided Manufacturing is a strategic business issued not just a technical issue. It argues that CAD/CAM is the single-most important weapon in the productivity war for the next decade. Benefits derived from CAD/CAM are substantial for discrete applications but greatest when there is an integrating function performed across the technical functions of the business through the computer systems involved.

author

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General Electric Company

conference

SME Education Forum
April 29, 1981
Detroit, Michigan

index terms

CAD
CAM
Quality
Productivity
Computers

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96-951 O—82——18

Good morning!

You will all recall the poem about the old woman who lived in a shoe. She had so many children she didn't know what to do.

Population is expanding frightfully in many parts of the world and yet the computer population is growing even faster. If the trends continue by the 1990's, there will be more computers in the world than there are people.

If we don't prepare ourselves, like the old woman who lived in the shoe, we won't know what to do.

But, of course, we can and we are preparing ourselves, so we will know what to do. Man is more than a machine. He's a reasoning, planning, adaptive, coping, being. Capable of managing the rush of technology.

Man has been using tools to ease physical tasks since the beginning of civilization: to improve his productivity.

But increasingly our tasks have become non-physical, informational tasks. Today, the world is bound together by an incredibly complex array of communicatons means which in the abstract can be likened to a giant global brain. The world runs on information. Our individual plants and businesses also run on information. And, handling information is the most fundamental task for all computers - from the giant Cray super computers to the bit-slice microprocessors.

It is only natural then that as the cost of a unit of computing dropped precipitously in the past decade, whole new manufacturing and engineering applications areas have become attractive. In fact, the economics are so overwhelmingly attractive in many areas that the computer technology advances are enabling new applications which provide stunning benefits. It is therefore imperative that companies not just accept the intrusion of computers into manufacturing. Indeed, an invasion should be and is underway in American business today - a "computer invasion" of the technical functions of the business. Under the label CAD/CAM.

Some see it as a pestilence; others as something thrust upon them by events beyond their control. But, many companies view CAD/CAM as an opportunity. As the single most effective weapon in the productivity drive for competitiveness. The companies who take the positive view of CAD/CAM as an opportunity will be the winners of the 1980's. The converse is also true.

With that as background, I'll cover the following topics today:

1) CAD/CAM - definition and scope.

2) CAD/CAM postulates.

3) Why is it important?

4) What are the technology drivers?

5) Caveats

6) Evolution and Future Vision.

First, definition and scope.

CAD/CAM goes by many names:
Computer aided design/computer aided manufacturing;
CAE/CIM - computer aided engineering/computer integrated manufacturing, etc.

Our attitude in General Electric has been, "I don't care what name you call it as long as you do a lot of it."

We choose, and I will use for this talk, a broad definition of CAD/CAM which encompasses essentially all of the uses of the computer in the technical functions of the business. Certainly, it includes all of these technology-related functions:

1) Interative Graphics
2) Information Storage and Retrieval
3) Position Control
4) Test and Inspection
5) Text and Display Graphics
6) Functional Computing

All computer applications in the technical functions of the busines. can be forced-fit into one of these six categories with functional computing being used somewhat as an "all other" category.

For example, Robotics is included under #3 Position Control. Text Processing goes under #5, etc.

You can see that this is a rather broad definition of CAD/CAM.

In General Electric, we use this classification system with a further classification in a second dimension - Work Function. The top work function breakdown is Engineering, Manufacturing, and Quality. There is a further sub-division under each major function. For Manufacturing, it is:

1) Facilities Planning
2) Process Development
3) Producibility Planning
4) Operational Planning
5) Materials
6) Plant Engineering

Comparable sub-classifications are used for the Engineering and Quality area.

We have cataloged nearly 10,000 applications under this system of classification, covering about 75% of the $15 Billion annual Sales Manufacturing segment of General Electric's total volume of about $25 Billion.

From this rather massive database, we have gained some new insights. What CAC/CAM is. What it is not. And, the trend directions and rate-of-change.

We discovered that in developing this database, we generated about 30,000 pages of handwritten material. You could say that we used an awful lot of paper to determine how well we were progressing toward the "paperless factory" of the future.

Some of the insights developed out of this effort were put into into postulates. Much of what follows is argument in support of these seven postulates and your challenges to these in the discussion period can be of value to us all.

The postulates are:

#1 CAD/CAM is a Strategic Business Issue not just a technical issue.

#2 CAD/CAM is generally good for the business as well as the people in the business.

#3 CAD/CAM progress is not generally technologically limited. Rather, it is paced by the limits of people and imagination.

#4 CAD/CAM makes major contributions to product quality as well as productivity.

#5 Inertia is the great inhibitor. Agents-of-change must be identified and nurtured to become apostles for CAD/CAM and counteragents of inertia.

#6 CAD/CAM does not reduce the size of the design staff even though it does increase design efficiency.

#7 Discrete applications are useful and profitable but the greatest benefits derive from applications which integrate across Work Functions.

The evidence is so strong on several of these items that they can be thought of as laws or axioms rather than postulates.

Brief arguments in support of these seven postulates are presented in the next few paragraphs.

Postulate #1: CAD/CAM is a Strategic Business Issue not just a technical issue.

It can drastically affect product quality, cost, market share, business responsiveness, design and production capacity, inventory costs, pricing, and capital utilization. On top of all that, it's a multi-functional organizational issue. So, the Business General Manager and all of the Functions line Managers have a stake. It is absolutely a pervasive issue and a strategic issue.

Postulate #2: CAD/CAM is generally good for the people as well as good for the business.

It makes getting good information easier; it allows doing a better job; it often involves job enrichment and upgrading; it eliminates junk jobs. Generally. Except for the exceptions.

Postulate #3: CAD/CAM progress is not generally technologically limited. Rather, it is paced by the limits of people and imagination.

Sure, there are things we would like to do that technology shortfall limits. Vision and tactile sensors for robots, voice-to-computer entry systems vocabular size, scheduling algorithms, in-plant data communications capability, etc. But, generally, the limits are imagination to see the application opportunity, sell-it in, implement and grow it.

Postulate #4: CAD/CAM makes major contributions to product quality as well as productivity.

Quality improvement showed up repeatedly, just behind productivity improvement as a major benefit from CAD/CAM applications across a broad range of types of businesses.

Postulate #5: Inertia is the great inhibitor and agents-of-change must be singled out and nurtured to become apostles for CAD/CAM and counteragents of inertia.

We use our Chiefs of Engineering and Manufacturing in this role all across General Electric. For the past three years, we have operated a Council comprised of 100 of these top technical managers. They have been forced-fed with information and given strong Corporate support to lower their risks in aggressive implementation of CAD/CAM applications. We have sustained a blitz-kreig of technical communications to the Council and to several hundred CAD/CAM Practitioners who work in their organizations.

We've used films, newsletters, speeches, conferences, workshops, and every-other means at our disposal. And, it has worked. Very few peole are now willing to say "CAD/CAM is O.K., but it doesn't apply to my business."

Postulate #6: CAD/CAM does not reduce the size of the design staff.

Yes, it does provide for more efficient design. Yes, it does allow better design. Yes, it improves final quality of the product. The evidence is that more designs and better designs are done to create better products that are more producible. But, the size of the design staff stays about the same. That is true across a wide range of business types.

Postulate #7: Discrete applications are useful and profitable but the greatest benefits derive from applications which integrate across work functions.

We do not work from a blank slate nor do we build many "greenfield" new plants. So, the task is to devise an "architecture" suitable for piecemeal integration and to evolve from today's discrete systems and applications into a future integrated structure. A computer-based Data Management and Control facility is critical to this approach and we are devoting a great deal of energy to this need.

Those are our postulates. They represent valid contemporary conclusions from a very large [illegible] of data representing a very diverse mix of business types.

Let us turn now to the technologies involved. What are the drivers? What's pushing and what's limiting?

Many technological forces are driving CAD/CAM but the most fundamental force is the continuous, dramatic improvement in the cost of a given electronic function through the development of increasingly dense and cost effective integrated circuit chips. Just recently, Hewlitt-Packard announced that they have produced a chip containing 450,000 transistors. That is tens of thousands of times more dense than chips of just a decade ago and the density of the chip reflects rather directly into reduced cost per function.

As important as cost is, it's by no means the only consideration. The continued reduction in physical size of electronic memory has allowed greatly increased computer and memory capacity and performance in a given amount of floor space. In just the past decade the volumetric efficiency of electronic memories has improved by a ratio of about 1000 to 1.

The micro technologies are still racing ahead at breakneck speed.

Function versus costs show a continued impressive improvement each year.

And the forecast is for more of the same as the semiconductor industry learns how to make ever more complex chips.

But, it's not just cost/performance that makes computers and, in particular, mini and microcomputers such an appealing opportunity. It's the role they have in enabling us to do functions previously impractical for technical reasons, independent of the economics.

What New Capabilities and Benefits Derive from These Technology Improvements?

The ability to distribute reliable computer power in terminals and small systems and connect these through data networks to host computers creating data base systems is fundamental to all of our plans for more extensive computerizing of the technical work functions.

Networks of terminals coupled with host data base systems provide a fantastic applications foundation. The data communications terminals population of more than 6 million now and 10 million by 1985 confirms the reality of network systems.

Again, the sheer number of terminals is not the total, nor even the most important significance of what is happening with the growth of network systems. Most important is the number of people who are brought into direct contact with the computer in their daily work. This represents a dramatic involvement of computers in the mainstream of the business with fundamental cultural and procedural implications to our organizations.

New functionality at terminals will have a major impact on computer based systems over the next few years.

In the one-to-three year, near-term period, we expect also some intriguing new functions to be available for production use which will challenge our imagination and analytical ability to utilize profitably.

Let me cite just one of these new technology based functions which is now in early production use.

Voice entry to computer, wherein production or inspection personnel speak in a limited natural language vocabulary directly to micro or mini computer-based interpreter hardware. The system accomplishes pattern recognition of the voice print and converts the information to digital form.

The rapid pace of the integrated circuit technology development is enabling many new hardware systems and sub-systems. But, our ability to cut costs and improve our products through their use will depend critically on the hiring, training and deployment of computer people - and especially systems and software people. These skilled people will pace our application work - not the hardware technology. Hardware only enables the applications by making them economically viable and technically doable.

The challenge with these new technologies is clear. To speed up the implementation of applications which convert the technological opportunity into savings, better products, and more interesting work for the people in the enterprise.

Well, this all sounds very upbeat and optimistic. Why isn't everyone into CAD/CAM up to their chins? Probably because there are some negatives. Start-up costs can be substantial. The costs are not always offset by immediate payback. Further, it takes real systems talent to design and implement good CAD/CAM systems.

We have found, for example, that there is a direct correlation between the number of technical graduate-level people and the number of new CAD/CAM applications started up in our operations. That data strongly suggests that technical graduates are required to identify, sell-in and implement at least the more complex CAD/CAM applications. We strongly suspect, also, that Systems' Engineering training is desirable and maybe even mandatory. Generally, we have found that the Engineering organization has taken the leadership in CAD/CAM in the past but that is changing, as it should. Full benefit realization requires a balanced team effort across Technical Marketing, Engineering and Manufacturing. To take its rightful place in this team, Manufacuturing must attract an unfair share of the best technical graduates over the next several years.

The final negative on CAD/CAM, worth of mention, is also an inhibitor. It is that CAD/CAM often goes against the grain. It is counter to the established inertia of the enterprise so that moving aggressively with CAD/CAM may force many people at least temporarily outside of the comfort zone of daily work habits.

What about Caveats, risks, and cautions? Surely, there are some very substantial caveats.

Caveat #1: Don't underestimate the human side of CAD/CAM.

Communications, information, education and openness are essential in large measures to combat the suspicion which is inherent in unmanaged change. More applications fail for human and behavioral reasons than for technical reasons. Personal commitment is essential.

Caveat #2: Don't create a CAD/CAM plan out of context with the business plan.

Such a plan is not sustainable over the long term. Funding and resources can only be sustained within the context of contribution to a business need.

Caveat #3: CAD/CAM increases risk exposure of the information resources of the business. The system solution must provide means for protection, security, and integrity over the long term.

The greater degree of integration and the more on-line the CAD/CAM systems become, the greater the risk exposure. This becomes an increasingly worrisome issue as the business advances to the latter stages of a CAD/CAM evolution and increased amounts of vital data becomes computer resident.

Caveat #4: CAD/CAM Revolutions are hard to control. Evolutionary development is much more practical.

Typically, four or five years are required for major evolution in a CAD/CAM push. Usually paced by people skills. Move with deliberate haste.

Caveat #5: Don't use only the financial measure for determining value of individual CAD/CAM applications.

The countable things in a business may represent less than 50% of what is of real value to the business.

Up to this point, we have covered CAD/CAM postulates, technology, and caveats.

Now, I'd like to present, briefly, a view of the future! - Where it's leading.

The structure or architecture of the future manufacturing business is not a giant plant, rather it is a distributed collection of small plants interconnected by broadband data communications capability. The suppliers and vendors of parts, materials, and services are also distributed and connected via data communications. Specifications, geometric definitions, inspection data, and similar information is all computer readable and computer resident.

The inventory at all levels from raw feedstock to finished goods is optimized across all stages of its life from the raw material vendor to the sales distribution channel.

So, the entire business is effectively on-line to computers with the attendant risks and benefits. The information resources of the business and the knowledge workers are the most important assets of the business. The operational tempo of the business is double or triple that of today's norm.

There can be little doubt about these trends. Much of the change is already underway. What is still not certain is how fast and in what industries. The real answer is probably Fast and Most.

We are more than a year into this decade. It's certain to be the decade of the manufacturing engineer. The biggest advances in CAD/CAM during this decade can be in Manufacturing. But, it will only happen if we attract the needed computer and systems talent into Manufacturing. That is the challenge for the colleges and universities and industries.

Faculty members who direct students predominantly to Engineering because "that's where the action is" will be party to a self-fulfilling prophecy. Because, surely, if we don't get the systems and electronics-trained engineers into Manufacturing, there won't be much action there in the 1980's. And, we will continue our slow slide into oblivion as a world leader.

Likewise, industry executives who fail to redirect substantially greater resources to renew plant and equipment; recruit and hire engineers for manufacturing; and fund start-up, training and integrating of new computer-based methods will be delinquent in their responsiblities.

The overriding challenge is to populate the ranks of the technical staff and the executive offices with people who think long-range as well as short-range; who think systems solutions; who combine technical awareness with good business sense; and who recognize the full magnitude of the CAD/CAM opportunity.

If we get the right people in America's manufacturing businesses in the 1980's, we will see America re-established as a formidable competitor in both the domestic and world markets.

Further, it can be great fun along the way and even greater satisfaction to close out the decade in prosperity and with pride.

Ladies and gentlemen, can there be any doubt that that is our challenge?

ADOPT A SCHOOL

A Program to Encourage
Implementation of MANUFACTURING Courses
into the Middle/Junior High School
Industrial Arts Programs

By

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Rationale:

There is an ever present need for the young men and women enrolled in our public schools to better understand business in general, and manufacturing in particular. The population of this country has but a vague comprehension of the organization, role and contributions of industry.

A recent study uncovered some distressing facts including:

1. 50% of all high school students could not distinguish between collectivism and a free enterprise society,

2. 50% of all high school students did not know the United States economy was based on free enterprise,

3. the median estimates of the United States public was that corporate profits were 28% on the sales dollar when the actual return was about 6%, and

4. the interrelationship of business, labor, investors, etc. in the economic system was understood by only one in seven Americans at large, and ONLY by one in three businessmen.

Similar statistics caused Luther Hodges to state, "if ignorance paid dividends, most Americans could make a fortune out of what they don't know about economics."

If young people are to take their place in society as contributing workers, investors, consumers, voters, and decision shapers, they must be better equipped intellectually. They must understand the role of manufacturing in our society.

Purpose:

To provide a more complete education of middle/junior high school youth, the Society of Manufacturing Engineers believes that courses in manufacturing should be introduced into the present industrial arts programs.

Materials available to help the local SME chapter.

1. Slide/Tape Program: "Manufacturing - An Integral Part of Society" - (approximately 16 minutes long)

2. Bibliography of Books, Transparencies, Filmstrips, Periodicals, and State Curriculum Guides.

3. Booklet for school decision makers - industrial arts teachers, principals, supervisors, superintendents

Strategy

No chapter can change all of the schools in their region, however, every chapter should be able to assist one or two schools in implementing this change. A procedure for this project might include:

1. Select the target school carefully. Criteria which may be used in selecting a likely candidate for change are:

   (a) a school with a record of accepting change, e.e. has an innovative science, math, reading, etc. program.

   (b) a school with which SME chapter members have contacts, i.e. are on the school board, know the principal or industrial arts teach, etc.

   (c) a school which is planning a new building - this is a good time to also develop new curriculum.

   (d) a school noted for a vigorous faculty.

2. Make an appointment to meet with the principal to discuss your ideas:

   (a) don't try a "back door" approach. Always include the principal.

   (b) seek the principal's advice as to who else should be at this first meeting. Let him or her invite other participants.

   (c) A meeting may be planned by the chapter as an "Educator's Night", inviting principals, administrators, etc., from several schools to make the presentation and offer to help facilitate curriculum development and stimulate student interest.

3. Come To The First Meeting Prepared.

   (a) read the booklet for Principals carefully -
   - take notes
   - underline important points
   - know the material

   (b) View the slides or filmstrip several times - the cassette tape has both audible and inaudible pulses to automatically advance the filmstrip or slides if the proper equipment is used. The tape should be started with the blank slide or filmstrip showing and advanced to the first title slide at the first

tone of the tape (approximately 5-10 seconds of music). Remember to check with script for exact match as you proceed. Without prior practice you may lose the confidence of the group if you do not show the presentation in a professional manner.

(c) be familiar with the bibliography - have the chapter order several of the more complete materials (Manufacturing Instructional Systems), The Manufacturing Forum, selected transparency masters or transparencies, and one or two filmstrips. Have these materials available for review.

4. Make Your Presentation.

(a) Indicate a sincere desire to help

(b) Discuss what "the real world" needs from school graduates

(c) DO NOT confuse Industrial Arts with Vocational Education.

Industrial Arts is a part of general education which studies Industry - in organization, personnel, systems, techniques, resources, and products; Technology - its evolution, utilization and significance; and their social-cultural impacts.

Vocational Education is specialized education designed to provide job-entry skills in a wide variety of occupations or occupational clusters.

Industrial Arts is like science, math, English and social studies. It provides citizenship background - NOT tool skills as a central theme.

(d) Do not claim to be a curriculum expert. Suggest the school, if interested, contact their State Department of Education, State College or University Industrial Arts Association (1201 16th St. N. W. - Washington, D. C. 20036) for help or name of consultants in the area.

(e) Offer the help of your SME Chapter. This could take several forms including:

1. A "grant" to the school to help acquire the initial curriculum materials.

2. Sponsor a "product contest".

3. Offer speakers for classes or career day.

4. Field trips to local industry, etc., etc.

5. Answer questions and record concerns.

6. Offer to return or help find individuals who can help them develop curriculum.

Good Luck! If you need additional help, feel free to contact:

Mark J. Stratton, Manager
Manufacturing Engineering Education
Society of Manufacturing Engineers
One SME Drive - P. O. Box 930
Dearborn, Michigan 48128
(For International SME Support)

or

Dr. R. Thomas Wright
Department of Industrial Education
Ball State University
Muncie, Indiana 47306
(For names of local or regional consultants,
and up-to-date bibliographical information).

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